The Medical Epitome Series

TOXICOLOGY

DWIGHT

PEDERSEN

The Medical Epitome Series.

TOXICOLOGY.

A MANUAL FOR STUDENTS AND PRACTITIONERS.

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AUTHOR'S PREFACE.

THIS volume is intended as a brief compendium of the facts in connection with Toxicology, which should be a part of the knowledge of every practising physician. It is more especially for the use of students, and is, of course, not intended to cover the ground exhaustively.

E. W. D.

BOSTON, 1904.

EDITOR'S PREFACE.

In arranging for the editorship of *The Medical Epitome Series* the publishers established a few simple conditions, namely, that the Series as a whole should embrace the entire realm of medicine; that the individual volumes should authoritatively cover their respective subjects in all essentials; and that the maximum amount of information, in letterpress and engravings, should be given for a minimum price. It was the belief of publishers and editor alike that brief works of high character would render valuable service not only to students, but also to practitioners who might wish to refresh or supplement their knowledge to date.

To the authors the editor extends his heartiest thanks for their excellent work. They have fully justified his choice in inviting them to undertake a kind of literary task which is always difficult—namely, the combination of brevity, clearness, and comprehensiveness. They have shown a consistent interest in the work and an earnest endeavor to coöperate with the editor throughout the undertaking. Joint effort of this sort ought to yield useful books, brief manuals as contradistinguished from mere compends.

In order to render the volumes suitable for quizzing, and yet preserve the continuity of the text unbroken by the interpolation of questions throughout the subject-matter, which has heretofore been the design in books of this type, all questions have been placed at the end of each chapter. This new arrangement, it is hoped, will be convenient alike to students and practitioners.

V. C. P.

NEW YORK, 1904.

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TOXICOLOGY.

CHAPTER I.

TOXICOLOGY.

Definition.—Toxicology may be considered as that branch of the Science of Medicine which has to do with the character, facts, and treatment of all forms of poisoning; and Forensic or Legal Toxicology is that branch of this subject which refers to the detection of criminal poisoning, and practice along these lines must be associated with a chemical and physiological knowledge of the subjects so treated.

A **poison** is a substance applied externally or taken internally, the ordinary effect of which, not mechanically, but by reason of its peculiar properties, is to produce sickness or death. A substance which produces death by purely mechanical action, such as broken glass, pins, nails, etc., should not be called a poison, although its administration result in death. In order that it should be considered a poison a substance must cause impairment of function or death as an ordinary or usual effect of its own inherent chemical nature. There are many instances when, as the result of disease or idiosyncrasy, a drug affects one person injuriously when it would not have a similar effect upon the average healthy individual, and under these conditions it can not be considered a poison. The intent with which a substance is given is a part of the legal conception of the word "poison," and in order that it should be so considered, it must have been given with criminal intent. The law, however, does not recognize the method of action of the substance, and it does not matter whether death results from the mechanical or chemical action; if it be given with

criminal intent, it is considered a poison. It is not necessary that a poison should be given in any particular way—that is, it may be rubbed into the skin, inhaled, swallowed, or injected under the skin or into the rectum, and still be a poison.

Administration of Poisons.—Poison may be introduced into the body in any of a great variety of ways. Any means may be employed by which it reaches the general circulation, by respiration and absorption through the lungs, by its introduction into the stomach or rectum, and from absorption through the lymphatics, or by subcutaneous injection. The rapidity with which it acts will depend to a considerable extent upon the method of introduction. Its action is most rapid when so introduced as to be distributed through the circulation with the greatest speed.

Mode of Action of Poisons.—Upon the introduction of a poison into the body it may have, first, a local effect upon the tissues with which it comes into contact; and second, a constitutional effect—that is, the symptoms due to its presence in the blood and upon the various organs. *Poisons may have either one or both of these actions.* It is not uncommon to have the first—that is, the local action—entirely wanting; and there are certain poisons, such as the stronger corrosives and irritants, whose most marked effect is a local one. The ordinary symptoms of poisoning are, however, the constitutional or general effects, and in order that any substance should give rise to these it is necessary that it should be taken into the blood and carried through the circulation. The presence of poison in the general circulation and the proof that it has been so absorbed may be obtained by chemical analysis and the discovery of the poison in the blood, solid viscera, urine, etc. In a medico-legal investigation of a case of poisoning, in order to demonstrate that death was the result of such poisoning, it is usually necessary to recover from the organs, blood, or urine, amounts of this poison sufficient to be consistent with death as a result of the particular substance under discussion. The rapidity with which the poison is absorbed will depend upon its solubility as well as the method of its introduction into the body.

Solubility of Poisons.—In order that a poison should be absorbed, it must be soluble; but it must be remembered that a number of chemical substances which may not be dissolved in water are readily soluble in the gastric juice or the blood.

Method of Introduction of Poisons.—It has been demonstrated that after **subcutaneous introduction** certain poisons enter the circulation within a very few seconds. If introduced into the circulation, their action will be very rapid. Providing that the poison reaches the circulation in an unmodified form, its action will be the same no matter what method is used to introduce it. Certain poisons, especially the animal and vegetable, are modified by the secretion with which they come into contact. If they be **taken into the stomach**, they may be so changed by chemical action as to be rendered innocuous. It has been said that the effect of a poison is the same no matter what method is used in its introduction. This should be modified in so far that the local action of a corrosive or irritant poison may obscure its constitutional symptoms. Poisoning may result either from the administration of a single dose sufficient to cause symptoms or death, or it may follow the repetition of several smaller doses.

Elimination of Poisons.—The elimination of a poison—that is, its discharge from the body, may take place *through any of the excreta*, such as the bile, urine, saliva, pancreatic fluid, and perspiration. At a varying time after the poison is taken into the circulation elimination begins; but as a rule it is not so rapidly eliminated as it may be absorbed, and portions are retained in the various organs of the body. As a result of this fact, when repeated small doses of a poison are taken its so-called cumulative effects will be noted—that is, as the amount of elimination is less during a given time than the amount of absorption, the quantity retained in the body is constantly growing greater, and as a result the symptoms produced increase in severity. The rapidity of elimination varies greatly with the different poisons. Arsenic may be found in the circulation and in the liver within a few hours from its ingestion. Lithium may be recovered from the per-

spiration within a few minutes after it is taken into the stomach. Other poisons, such as antimony, are much slower in their elimination, and this metal has been discovered in the excreta after the lapse of four months from its taking. The proportion of a dose which is in the circulation at any given time is very small, and the constitutional effects manifested are due to this amount; that which is in the stomach or which has been through the circulation and is retained in any of the organs is probably innocuous. Questions as to the elimination of the poison are frequently raised in connection with cases of homicide. Several cases have been reported of death undoubtedly resulting from acute arsenical poisoning, yet it was impossible to recover arsenic from any of the organs. In a case in which positive evidence of the taking of a definite poison was present chemical analysis might not be of the greatest importance, but the possibility should be recognized of death from such a poison without the ability to recover it from any of the organs.

The Influence of Disease upon Poisoning.—The presence of disease in an individual may materially modify the effect of poisons. In dysentery, tetanus, cholera, hysteria, delirium tremens, and peritonitis a very large dose of opium may be given without producing poisonous effect. In certain cases of cerebral hemorrhage, 2 to 3 grains of strychnine have been given without toxic result; while, on the other hand, the administration of even a small dose of opium in a similar case would be followed by serious symptoms.

The Influence of Idiosyncrasy upon Poisoning.—The effect of poisons upon different individuals varies to a great extent, and there are people who, without previous experience, can take a very large dose of a given poison without any ill effect, while another individual may take a very minute dose and be seriously poisoned. Cases have been reported in which an individual was able to take $\frac{1}{4}$-grain doses of strychnine without constitutional effect, and these were in persons in whom the best of reason was present for believing that strychnine had never before been taken. On the other hand, there are cases in which the medicinal use of $\frac{1}{200}$ grain

is followed by marked toxic symptoms. The same might be said of almost any other drug. There are substances not generally considered poisonous in character which act upon certain individuals as violent poisons. There are a number of persons in whom the eating of various forms of shell-fish is followed by violent symptoms. Aside from the influence of idiosyncrasy, the general condition will have an effect upon the action of drugs, so that one enfeebled by accident, disease, or age, will be usually much more affected than a young, strong adult. As a rule men can take larger doses than women without symptoms of poisoning.

Antagonism of Poisons.—It has been satisfactorily demonstrated by experiment that between certain poisons there is a definite antagonism; also that this antagonism may be of two sorts: first, chemical, by means of which a chemical action takes place between the two substances, changing them so that the action of both is neutralized; and second, the physiological, when the action of one drug is counteracted by that of another. As an example of the last, certain forms of calcium in poisonous doses result in complete ventricular spasm of the heart, the animal dying with the heart in systole. The effect of the salts of potassium is, on the other hand, relaxation of the ventricles, and death occurs in diastole. If both these poisons are given, and the dose of each carefully regulated, the effect of one will be entirely controlled by that of the other, so that toxic doses of each may be given without material effect upon the animal.

A similar antagonism exists between veratrine and the potassium salts; morphine and atropine; aconite and digitalis; conium and strychnine, and many others. If the balance is not so accurately kept as to avoid toxic effects, still the presence of two of these drugs with antagonism one to the other will modify to a great extent their action, and the result will be different than if they be given singly.

Compound Poisoning.—It is sometimes claimed, as in the famous trial of Paul Schoeppe, that when poisons are given at the same time, even if they have no definite antagonism, each may so modify the action of the other as to obscure

those definite symptoms upon which a diagnosis is based. It is undoubtedly a fact that this may occur under certain conditions; but usually, without there be a definite antagonism between the two substances, the symptoms of the poison which caused death will be present, although they may be somewhat modified in form.

Postmortem Imbibition of Poisons.—It has been demonstrated by experiments that it is possible for poisons introduced into the stomach, intestine, and peritoneal cavity after death to find their way gradually to very remote parts of the body. This matter is of importance for two reasons: First, and most commonly, that after a body has been embalmed or preserved by the introduction into any of the great cavities or into the circulation of a fluid containing poisonous substances, it may be impossible to state positively whether poison of the same kind found in the organs was introduced before or after death; and in this way it frequently happens that for purposes of medico-legal investigation a body is rendered almost if not completely valueless by embalming. It is also of importance, secondly, in that it would be perfectly possible for purposes of revenge to introduce into a dead body poisons, and later on after weeks or months originate gossip which would result in the disinterment and investigation of the body in an attempt to fasten the crime of poisoning upon some individual. Reese and McCracken carried on some experiments along these lines, and after the introduction of various substances, including arsenic, into the stomach of dead animals, followed by burial for six or seven weeks, arsenic was recovered from the spleen, intestine, omentum, both kidneys, and the bladder.

Miller and Sutton have apparently demonstrated that if sufficient time be allowed, arsenic, having been injected into the stomach after death, may be discovered in the brain, spinal marrow, and even the bones of the head. Witthaus recovered from the brain 0.00828 gramme of arsenous oxide five days after the injection of 16.56 grammes in solution into the stomach. From the chemical analysis alone it will be impossible in some cases to say as to whether the poison

found had been introduced into the body before or after death; but a decision can usually be reached from the conditions associated with it; as, for example, it would be difficult to introduce into the stomach solid crystals of arsenic without leaving behind some evidence of the method employed, so that if no external evidences be present, and crystals of arsenic are found in the stomach, it would be highly improbable that they had been introduced after death: if a solution had been used, a decision might be more difficult. The cases in which this question would seriously arise are infrequent, and will be largely limited to bodies which have been disinterred after burial for a considerable length of time.

Evidences of Poisoning.—The evidence upon which a case of poisoning is based will be of four varieties: first, symptoms presented during life; second, postmortem appearances; third, the results of chemical analysis; and fourth, moral or circumstantial evidence. The first three may be said to be strictly medical, and it is with those we have to do.

Symptoms of Poisoning.—Poisoning may be of acute or chronic character. It is characteristic of acute poisoning that the symptoms present themselves with great urgency in a person previously healthy. The poisons usually chosen for suicide or homicide are those whose action is rapid, and as a rule death follows so rapidly and under such circumstances that attempts at interference with their action are not successful. The symptoms presented in an individual case will, of course, depend largely upon the character of the poison used, the rapidity with which its symptoms ensue, and the dose.

Given a case of a previously healthy individual who, after the taking of food or medicine, is suddenly seized with violent and acute symptoms, the suggestion is always of poisoning. There are certain diseases and conditions coming on in the same way which are not infrequently mistaken for poisoning, and whose symptoms may closely resemble either those of poisoning in general or of some definite poisoning. Such are cholera, cholera morbus, peritonitis, apoplexy, tetanus, etc.

It is frequently impossible from the symptoms alone, without taking into account the surroundings and circumstantial

evidence, to make an absolute diagnosis of poisoning. When after partaking of the same food or medicine, several or a considerable number of persons are similarly affected, the presumption of poisoning is much strengthened. If, after a number of people have partaken of the same food, one alone is suddenly affected, the presumption of poisoning is weakened. Many other surrounding conditions will modify the probabilities of poisoning in any given case.

Symptoms may be due to repeated small doses, in which case they may be slow and insidious in their onset; or poison may be given with homicidal intent to those already suffering from disease, and the poison may be so skilfully selected as to result in what is apparently an increase in the severity of the disease, and to produce symptoms simulating those which might be expected in the disease already present. Other conditions will modify the rapidity with which the symptoms come on, such as the condition of the stomach, whether full or empty, the presence or absence of antagonizing drugs, or idiosyncrasy on the part of the individual.

As has been said, the symptoms presented in the living depend largely upon the character of the poison taken. Poisons being divided according to the symptoms presented into irritants, neurotics, anæsthetics, depressants, and asthenics, and according as the material taken belongs to one or the other of these groups, the symptoms presented will follow along the lines suggested by this classification.

When for any reason the question of poisoning is seriously considered, the chemical examination of the material in which the poison is supposed to have been contained or disguised, together with a chemical analysis of the vomitus and excretions, will frequently enable us to make a positive statement as to the presence of poison together with its chemical character. When the results of such chemical analyses are positive—that is, when the poisoning substance can be found, as, for example, in food, a portion of which had been taken, and also found in the vomitus—such a test will become of the greatest importance and demonstrate positively the facts in the case.

Feigned Poisoning.—In investigating a case of suspected poisoning it must be remembered that cases of feigned poisoning are not exceedingly rare. The decision in such cases should be based, in so far as is possible, upon chemical analysis. It is rare that the individual feigning poisoning has a sufficient knowledge to simulate so closely the symptoms following poisoning by any particular drug that the feigning will not be discovered upon a careful examination and consideration of the symptoms.

The Duties and Responsibilities of Medical Men in Cases of Poisoning.—The duties and responsibilities of a medical man in cases of suspected poisoning should be thoroughly appreciated. While the first duty of the practitioner is to save life, if that be possible, it should also be remembered that he owes a duty to the State as well as to the individual, and he should therefore take advantage of all opportunities which would assist in the detection of crime and the conviction of the criminal.

In considering the symptoms presented in cases of poisoning it is important to remember the fact that an absolute diagnosis can not be based upon the symptoms alone. There is no poison the symptoms following which are always characteristic or always the same, and the same poison results in varying symptoms in different individuals. For this reason too much stress can hardly be laid upon the importance of chemical analysis in all cases of suspected poisoning, and the medical witness should hesitate to make a definite statement or decision without such careful analysis has been followed by positive results.

Postmortem Appearances of Poisoning.—When the body of an individual supposed to have died from the effects of poisoning is presented for examination, we should first gain all the knowledge possible as to the conditions surrounding the death. Not only should the symptoms which were present be studied, but the circumstances surrounding the case as well, and a chemical analysis should be made of food or fluids which may have contained the poison, together with vomitus if any be present. The time elapsing between the first occur-

rence of symptoms and death should be known, and while such evidence is not conclusive, it may be of material assistance in rendering a decision. It will be of value not only in deciding as to the particular poison used, but may be of value also in proving that death was not the result of poisoning. The external appearance of the body, particularly about the mouth, will frequently furnish very suggestive evidence as to the character of the poison employed. In a case of poisoning by one of the stronger irritants, such as carbolic acid, ammonia, nitric or sulphuric acid, there will usually be found about the lips, tongue, and fauces local evidences of the corrosive action resulting from the use of the particular irritant. If the investigation be made within a short time after death, the odor of a definite poison may sometimes be detected. This odor will be more noticeable when the body is opened, and in some cases, as in carbolic acid poisoning, it may be detected many hours or even days after death.

If the poison be volatile, as is the case with hydrocyanic acid, this odor, very noticeable within a few hours after death, will have entirely disappeared at a somewhat later time. Upon opening the body attention should be paid to two main lines of investigation, observation of postmortem conditions, and a preparation for chemical analysis. In cases of homicide, it is probably never safe to base the decision upon postmortem appearances alone, and the chemical analysis of portions of various organs and of the contents of the stomach and intestine is necessary. The first should be subordinated to the second. Observations should be made in such a way and limited in their extent so as not to interfere with the making of a satisfactory chemical analysis. Perhaps the most important organs to be examined are the stomach and intestine, and these for two reasons: first, because when any of the stronger irritants are used, the effect upon the stomach and upper intestine is more clear and characteristic than upon any other organ; and secondly, because death, as a rule, in cases of acute poisoning results so rapidly that time is not allowed for the stomach to

empty itself completely during life, so that traces or considerable amounts of the poison taken may be usually recovered from the contents of the stomach. At the autopsy great care should be taken to remove the stomach and its contents, together with such other organs as it may be desirable to analyze, to place them in such receptacles and transfer them in such a way to the chemist as to make it impossible for substitution or contamination to occur.

As in the case of evidence derived from the living, it must be remembered that the postmortem appearances do not give, when considered alone, absolute proof that death was the result of poison or any definite poisoning. The postmortem appearances of poisoning may be so closely simulated by those resulting from disease as to make the decision between them impossible; and if our decision must be based upon the postmortem appearances alone, it should be given cautiously. In cases of homicide it will not be accepted as sufficiently accurate to base a conviction upon. When typical postmortem appearances are combined with an accurate knowledge of the conditions surrounding the individual during his life up to the last moments, it may be possible to make a full and absolute statement as to the cause of death and the particular poison employed; but even then the chemical analysis will so greatly strengthen the case as to make it desirable, if not necessary, that in all cases of suspected poisoning in which the question of homicide may be discussed, it should be strengthened by a careful chemical analysis of the organs and tissues.

Evidences from Chemical Analysis.—Chemical analysis in cases of suspected poisoning frequently presents the most delicate and difficult problems in connection with the study of legal medicine, and in order that evidence drawn from such analysis should be of any value it is important that every detail connected with it should be carried out with the utmost care and accuracy. The individual making the analysis should not only be a chemist of experience, but also one who is familiar with medico-legal problems; and it is rare that a general practitioner is sufficiently trained along these

lines to justify him in making such tests or drawing conclusions from them. In cases of homicidal poisoning a decision is usually based upon the testimony of the chemist and upon evidence associated with his analysis. It is therefore essential that the person making these tests should be the one of all available who is by experience and training best fitted for such work.

Questions as to the identification of the specimens are always raised, and the chain of evidence from their removal from the body to the end of the test must be an absolute one and the possibility of substitution or adulteration must be eliminated. The detection of poison in the stomach does not prove that death resulted from its action. The presence of a poison in the blood, brain, liver, kidneys, and other organs is of much greater importance, and for this reason the investigator must not be satisfied with the sending of the stomach and its contents for analysis. Portions of the various organs should be removed and analyzed in all cases.

Evidences of Poisoning from Experiments on Living Animals.—Experiments on living animals may be made either to corroborate decisions arrived at in other ways; or when it is impossible to identify the poison in any of the ways previously considered, it may be possible to demonstrate that the unknown substance had definite toxic action by noting its effects when introduced into the body of some of the smaller animals. It must, however, be remembered in making these experiments that putrefaction, fermentation, or disease may develop in the human body substances which are poisonous and fatal when injected into any of the lower animals.

Classification of Poisons.—Any classification based upon the physiological action of drugs, and especially upon the physiological action of poisons, must be to a greater or less extent an arbitrary one. Some authors, recognizing this fact, have classified them according to their chemical constitution or their natural history into organic and inorganic, or various other divisions. For our purpose, however, it seems best to follow a system of classification suggested by Taylor, and

carried out by most authors in legal medicine—that is, a classification based upon their physiological action.

By this system **all poisons are grouped under two heads,** irritants and neurotics. In the first class of **irritants** are included all those poisons which have an irritating and destructive action upon the tissues with which they come into contact, and when taken into the alimentary canal are followed by a greater or less amount of irritation, inflammation, and destruction of the tissues lining that canal. As a result of this local effect the ingestion is followed by nausea, vomiting, purging, and pain, the matter discharged from the stomach and bowels frequently containing blood. On post-mortem examination there will be found a greater or less degree of inflammation of the gastro-intestinal lining, which may even result in ulceration, perforation, or gangrene.

Irritants are again subdivided into irritants proper, under which head are included all those chemicals whose poisonous effect largely, if not entirely, depends upon their irritant and destructive action upon the tissues with which they come into contact. In this class will be found all of the stronger acids and alkalies. Second, specific irritants, including a group of mineral, vegetable, and animal substances whose poisonous action depends not only upon their irritating effect, but also upon specific physiological results which follow the taking of the individual poison. In this class are such metals as arsenic, antimony, mercury, lead, copper, etc.; non-metallic substances like phosphorus, iodine, bromine, and chlorine; vegetable irritants such as oxalic and tartaric acids, croton oil, elaterium, and such animal poisons as cantharides and the albumens developed during putrefaction.

Neurotics.—Under the general heading neurotics are included a series of poisons which have specific action upon the great nerve-centres, the symptoms which they present being those dependent upon their action upon the brain and spinal cord, such as drowsiness, headache, delirium, coma, convulsions, or paralysis.

Subdivisions of neurotic poisons are: cerebral neurotics, including anæsthetics and depressants; spinal neurotics or

tetanics; and cerebrospinal neurotics or deliriants. The dividing-line between these various classes of poisons is not always a clearly defined one and can not be sharply drawn.

QUESTIONS.

What is toxicology?
How may poisons be administered?
How may poisons act?
Upon what does the rapidity of their absorption and elimination depend?
How may the presence of disease influence the action of a poison?
What is meant by the antagonism of poisons?
What is meant by postmortem imbibition?
Upon what evidence is a decision in a case of poisoning based?
According to what system are poisons classified?
How are the two general classes of poisons subdivided?
What are the members of each subdivision?

CHAPTER II.

Dec. 21-06

THE IRRITANT POISONS.

SULPHURIC ACID.

Sulphuric Acid (Oil of Vitriol, H_2SO_4) is obtained by burning sulphur or iron pyrites and allowing the products of combustion to mix with fumes obtained from the decomposition of nitre.

Properties.—Sulphuric acid of commerce is a dense, colorless, inodorous liquid with a specific gravity of 1.845, an oily appearance, and with strongly corrosive and caustic effect upon living tissues. It readily unites with water, and when the fluids are mixed heat is evolved.

It is used largely in the arts, perhaps more than any other acid, and it is also employed in the manufacture of many of the other acids. It is largely used in the manufacture of alum and sulphate of iron, phosphorus, chlorate of lime, and magnesium sulphate; also in bleaching, tanning, and dyeing,

In medicine it is used as a caustic in the form of ointment, as a counterirritant, and has been recommended, either alone or in combination, in cholera, chronic diarrhœa, lead-poisoning, etc.

Criminal Uses.—Sulphuric acid on account of its common use and the familiarity of the public with its destructive action is, perhaps, more commonly than most of the other acids the agent in homicidal deaths, especially among infants and young children. It is also the common agent employed for disfigurement, when by reason of jealousy or revenge an assault with disfigurement is aimed at. When the strong acid is thrown upon the skin, a white stain first appears, which later takes on a dark-brown or blackish color.

Toxic Dose.—The dangerous effect of sulphuric acid depends to a greater extent upon its concentration than upon its amount, and the quantity required to produce death will depend largely upon the conditions under which it was taken. If the stomach be full, the acid may spend its force upon the stomach contents, and by the time it reaches the walls be so diluted as to have little effect. The smallest fatal dose reported is that of a half-drachm in a child of about a year, and one drachm in an adult.

Death follows the taking of sulphuric acid at periods varying from three-quarters of an hour to two or three days, and when the result of the secondary effects of the poison the time may be almost indefinitely extended.

Symptoms.—When concentrated sulphuric acid is taken into the mouth, symptoms present themselves immediately. Its irritating action upon all the tissues with which it comes into contact is followed by severe burning and pain in the mouth, or extending down the throat into the stomach, and there is vomiting which occurs at once and consists of frothy material, shreds of mucus, liquid of a dark coffee-ground color, with more or less blood. Shreds of mucous membrane are found even in the first vomitus. The mouth is excoriated and its lining membrane is at first white, later changing to gray or brown. Salivation is marked. The injury to the lining of the mouth, throat, and œsophagus is followed by considerable swelling and difficulty in breathing, the face usually taking on the livid expression of asphyxia. The material which is first vomited usually contains a large portion of the acid in a concentrated form, so that wherever it may

touch the hands or clothing there will be found stains due to the action of the acid. The expression is anxious, the evidences of suffering and pain very great, the intellectual faculties clear, and death usually results suddenly at the end of eighteen to twenty-four hours after the poison is taken.

Treatment.—When a strong acid has been taken, there is no substance which will have any material effect upon its action. The proper treatment would be an attempt at dilution and the administration of mild alkalies, such as cooking soda, chalk, or magnesia, with the usual soothing substances like barley-water, flaxseed tea, or oil. No tube should be introduced on account of the danger of perforating the already softened œsophagus and stomach.

Postmortem Appearances.—These appearances may vary according as death takes place rapidly or slowly. The mouth, larynx, trachea, and œsophagus are stained grayish or black, and the mucous membrane hangs in shreds. The stomach will be in the same condition, softened and perhaps perforated. The contents of the stomach will be dark colored, due to altered blood and the effect of the acid upon the stomach contents. If a perforation has resulted, its edges will be ragged and the adjacent viscera colored from the action of the acid. If life has been sufficiently prolonged, a similar condition may be found in the intestine.

Tests.—All of the thickened and viscid organic matter should be boiled in distilled water, filtered, and the various tests for sulphuric acid and the sulphates applied, the most accurate, perhaps, being the barium tests.

When the solution to be examined is a concentrated one, its corrosive action will be very apparent: even if it be very dilute and a glass rod be introduced into it and then drawn lightly over ordinary writing-paper, and the paper then carefully and slowly dried by gentle heat, it will be found that a dark-colored line will appear marking the course of the rod. When a concentrated sulphuric acid is applied to dark cloth, a reddish or reddish-brown stain is left, moisture being apparent for a very considerable time. Other materials are usually stained a bright yellowish red.

In the pure state sulphuric acid may be recognized by its oily appearance, its weight, its charring of organic matter, the heat thrown off when it is mixed with water, and the sulphurous fumes given off when it is heated with metallic copper or mercury or with wood or charcoal. When to sulphuric acid in solution, mixed with organic matter, a few drops of nitric acid are added and then any of the salts of barium, a white precipitate will be formed which is insoluble in nitric acid. The pure acid, even in a diluted form, if treated with a small portion of veratrine and then evaporated to dryness, will give a brilliant crimson-purple color. Sulphates are not affected by this test.

Illustrative Cases of Sulphuric Acid Poisoning.—CASE I.—Whitton and Turner (*Australas. Med. Gaz.*, 1890–91, x. 299) report a case of poisoning by sulphuric acid in a man aged sixty-three. The amount swallowed was about a teaspoonful. About two hours after taking the poison he was seized with vomiting, and continued to vomit large quantities of black blood almost without interruption for the next six hours, after which the color of the vomited blood changed to a bright red under treatment and became much diminished in quantity and frequency. When seen, about eight hours after taking the acid, his breathing was very labored and accompanied with a raucous sound. He kept his lips apart, but they were not scarred in any way, though the tongue, especially at the posterior part of the dorsum, was very much wrinkled and burnt. Complexion pallid, feet and hands cold. Pulse 74; respiration 26; temperature (under axilla) normal. He had little pain except that caused by dyspnœa and a constant feeling of soreness about the sternum one inch above the xiphoid cartilage. He was never unconscious, and spoke with difficulty and with a very hoarse voice. Patient improved somewhat under treatment, but died suddenly in collapse twenty-three or twenty-four hours after taking the poison.

Postmortem Examination.—"On opening the abdomen a quantity of bloody fluid is found. Lungs, liver, kidneys, and intestine normal. Heart soft, empty, and flabby. Stomach:

the whole of the lesser curvature is deeply eroded and covered with black clotted blood, which can not be removed without tearing. On the anterior surface about an inch from the pylorus is a small perforation, and about two inches from the pylorus on the anterior wall is a second but much larger perforation. The whole of the pyloric end of the stomach is very friable. The greatest curvature is very little differing from normal, the large eroded patch being practically continuous, with one exception. In parts where the erosion is not so marked, there is an area between the latter and the normal mucous membrane, with only a sign of deep congestion but without erosion. The tongue is denuded of epithelium from about an inch from its apex, while at the anterior portion some desquamated pieces may be seen hanging loosely; tonsils normal, but about the upper two inches of pharynx the mucous membrane is acutely inflamed and presents a much reddened appearance. Proceeding down the œsophagus very slight signs of inflammation, but the mucous membrane is covered with a mucous, reticulated streak of blood, which can be easily removed. At entrance to stomach the same appearance is noted as at the pyloric end, but until the very entrance not the slightest trace of erosion or ulceration. Larynx shows signs of inflammation, especially about the region of the vocal cords, while slight inflammation may be noted as far down as the bifurcation of the trachea; no ulceration or injury of any great extent."

Case II.—Thomas (*Med. Times and Gaz.*, London, 1873, ii. 92) reports a case of poisoning by about two ounces of the strong oil of vitriol in a man aged thirty-four.

State on Admission to Hospital.—Patient was quite insensible; pulse weak and feeble; stertor; extremities cold. He had vomited once on his way to the hospital; his lips were white, but there were no marks of acid on the face. A solution of magnesia was given, after which he vomited a quantity of black-looking fluid, consisting of blood, mucus, and epithelium, which had a strong acid reaction. He spoke only

once while in the hospital, and that was to mention his name. He died eight and a half hours after taking the acid.

Postmortem Examination (*thirty-two hours after death*).—Rigor mortis well marked; lips white and dry; front teeth blackened, but none of them were loose; the tongue and roof of the mouth were dry, shrivelled, and of a brownish-black color; the epiglottis was shrivelled slightly and of a dirty brown color. On opening the larynx the cords were seen to be covered with a brown glutinous liquid. The trachea was inflamed and covered with a like liquid. Similar appearances were found in the bronchi, even into their divisions in the lungs. The lining membrane of the œsophagus was black and very much charred. On opening the stomach some black glutinous liquid escaped. The wall of the stomach presented similar appearances to the œsophagus, only in greater degree, the charring being more marked. There was one large perforation at the commencement of the greater curvature at the cardiac end of the stomach; there were several very thin spots on the wall, but no other distinct perforation; the contents of the stomach had escaped through this perforation into the abdominal cavity. The pylorus was contracted. The appearances in the duodenum were similar to those in the stomach and œsophagus. There were also two perforations, one about two inches from the pylorus, and the other about three inches further on. In the jejunum the charring was not so marked; it had the color of dirty white paint; it had not gone further than the jejunum. The peritoneum was black at the upper part of the abdominal cavity. The under surface of the left lobe of the liver was also blackened. Heart: left ventricle contracted, there was one small clot in it; right ventricle, several clots in it, but it was not full. Lungs, spleen, and kidneys diseased but not affected by the poison.

Jan. 2-07

NITRIC ACID.

Nitric Acid (Aqua Fortis, HNO_3) may be obtained by the action of sulphuric acid upon potassium nitrate, which is then heated.

Properties.—At first it is a clear colorless liquid, of specific gravity 1.42, which changes to a yellowish color upon exposure to light. It oxidizes all the common metals except gold and is exceedingly corrosive when applied to living tissue. On all animal and vegetable tissues it leaves an indelible yellow stain. When diluted, it changes most animal and vegetable substances into oxalic, malic, and carbonic acids.

In medicine the uses of nitric acid are as a tonic, antiseptic, and astringent, and it is supposed to have some definite stimulating effect upon the intestinal glands. It is used at times internally in cases of intestinal indigestion, syphilis, hepatitis, and as a solvent for uric acid and phosphates when highly diluted. It is used externally as a stimulating dressing for ulcers, and in its concentrated form it is, perhaps, more commonly than any other acid, used as a caustic.

While nitric acid is in common use in the arts and in medicine, it is rarely administered as a poison either in homicidal or suicidal cases, and deaths from its employment are rare.

Toxic Dose.—The smallest dose that has been reported as causing death is about 2 drachms in the case of a boy of thirteen, who died in thirty-six hours. Soberheim quotes a case of poisoning by nitric acid in which death occurred in one and three-quarters hours, and this is believed to have been the shortest case on record. Taylor quotes Tartra as recording one in which a woman died from exhaustion, produced from the secondary effects, eight months after having swallowed it.

Symptoms.—The symptoms presented in poisoning by nitric acid are similar to those produced by sulphuric acid, except that the tissues with which the acid comes into contact are stained yellow, as are also clothing and other materials spotted by the acid. The pain is not perhaps so severe as that with sulphuric acid, the vomiting is rather less persistent, and the vomited matter is yellow or brown. The fumes of nitric acid being extremely poisonous or irritating, an acute inflammation of the air-passages is developed

soon after its taking. As the chemical action of the poison tends to the production of gas, the abdomen is swollen, tense, and tender; the pulse small, rapid, and irregular; prostration marked and swallowing painful.

Treatment.—The treatment of poisoning by nitric acid is, on account of its extremely irritating qualities, as unsatisfactory as of that by sulphuric acid. The stomach-pump, or the introduction of any tube, should be avoided on account of the friable condition of the œsophagus and stomach. Mild alkalies, oils, and soothing liquids may be given and the general condition treated symptomatically.

Postmortem Appearances.—The lips, mouth, fauces, and œsophagus will be stained a yellow or yellowish brown; the mucous membrane in the same regions will be softened, peel off readily, and probably be found in shreds. The stomach will probably be distended by gas, and, as is the case with any of the stronger acids, its walls may be softened, ulcerated, or perforated. The contents of the stomach will be green or yellow, the lining membrane congested. Similar conditions but diminished in intensity will be found in the upper part of the small intestine. In chronic poisoning emaciation is a noticeable feature.

Tests.—Stains upon clothing should be soaked in warm distilled water, neutralized with potassium carbonate, and the resulting crystals washed with alcohol. If they are potassium nitrate, they will appear in the form of long, fluted prisms which neither effloresce nor deliquesce on exposure to air. Sodium nitrate crystals have a rhombic form similar to those of common salt. When strong sulphuric acid is added to these crystals, a colorless acid vapor is slowly given off. When to the crystals are added copper filings and a few drops of sulphuric acid, red nitrous fumes are given off.

The concentrated acid may be recognized by the yellowish stain which it produces, by the reddish-brown fumes it gives off when exposed to the air, and by its bleaching power in a solution of indigo.

The diluted acid is recognized by its acid reaction, by the fact that silver nitrate or barium nitrate when added has no

effect, as it would have were it sulphuric or hydrochloric acid; by its power to turn morphine or brucine red; and by the fact that when combined with hydrochloric acid gold leaf is dissolved.

Illustrative Cases of Nitric Acid Poisoning.—CASE I.—Crisp (*Trans. Path. Soc.*, London, 1861, xii. 114) reports a case of poisoning by nitric acid in a man aged thirty-eight, who swallowed about four drachms of the pure acid. The symptoms were burning pain in the region of the stomach; vomiting on the first day; shreds of mucous membrane from the mouth and œsophagus; the bowels confined; liquid food only taken, and that with difficulty; the voice not materially affected; the intellect unimpaired. No urgent symptoms appeared until the fifth day after taking the acid, when he lost blood by the mouth, became extremely restless, and gradually sank.

Postmortem Examination (*day after death*).—The tongue and fauces were ash-colored, with patches of denuded mucous membrane. A large portion of the œsophagus from the fauces to the cardiac orifice was in a sloughy condition. The mucous membrane at the cardiac end of the stomach was destroyed to the extent of about six square inches, this part being of a brownish-black color. The lining membrane of the remaining part of the stomach was soft, swollen, and ecchymosed. The mucous membrane of the duodenum and upper part of the jejunum was also swollen and ecchymosed. The stomach and intestine contained a large quantity of chocolate-colored bloody fluid. Other organs normal.

CASE II.—Temple (*Boston Med. and Surg. Jour.*, 1884, cx. 496, Case IV.) reports a case of poisoning by fumes of nitric acid in a man aged fifty-four, resulting from the accidental emptying of a carboy of commercial nitric acid. Four hours after the accident he was not feeling just right, and shortly after this he began to cough. Coughing was painful, and was increased by deep inspiration. Face pale and expression anxious. Pulse rapid and compressible, 124. Respirations rapid and shallow. After resting two hours he regained natural color. Complained only of feel-

ing weak and a tightness about chest. Cough much diminished. On his way home he noticed that he walked with a dragging step, with some loss of muscular power. During the night he coughed almost incessantly, expectoration being frothy and of a straw color. Died the next day, thirty-three hours after the accident.

Postmortem Examination (*forty-eight hours after death*, by Dr. Draper).—"Both lungs free. Heart: right auricle a little distended but not engorged. In posterior wall of right auricle four small ecchymoses grouped. Whole heart retains blood which is of dark color and firmly clotted. Size and structure of heart normal. Endocardium normal. Lungs: external color of left lung rather darker than normal, pits on pressure, markedly œdematous and crepitant in every part. Bronchial mucous membrane but little reddened and with no apparent swelling. Right lung more deeply reddened, with more tendency to engorgement. Mucous membrane of larynx and trachea injected to a marked degree; just above the bifurcation of the trachea and at the opening of the right bronchus are four minute submucous ecchymoses the size of a pin's head. Vocal cords free, and chink of glottis open. Epiglottis: its inferior surface shows marked congestion, and at its base several submucous ecchymoses the size of a pin's point. Kidneys and liver injected. Stomach, intestine, and spleen normal."

HYDROCHLORIC ACID.

Properties.—Hydrochloric Acid (Muriatic Acid, Spirit of Salt, HCl) is of bright-yellow color, specific gravity 1.15, gives off fumes when exposed to the air, and is commonly contaminated with nitric acid, arsenic, and antimony.

It is usually prepared by the action of sulphuric acid on sodium chloride or common salt.

It is commonly used in the arts, both alone and in combination with sulphuric acid, as aqua regina, when it dissolves silver; and with nitric acid, as aqua regia, when it dissolves gold.

Hydrochloric acid is frequently used in medicine in its dilute form internally in certain digestive disturbances, sometimes in syphilis, and to counteract phosphatic deposits in urine. It is sometimes used externally as a caustic, when its action is not so powerful as that of nitric acid. In medicine the dose is from 5 to 10 drops of a dilute solution. It is rarely used as a poison in cases of homicide or suicide.

Symptoms.—Hydrochloric acid is a strong corrosive irritant, but not so strong as either nitric or sulphuric acid. The symptoms produced are similar but less in severity than those due to other acids. Dark clothing is stained at first a bright red, changing to a reddish brown. Mucous membranes are stained white or grayish, and a false membrane is sometimes formed in the fauces. The shortest period within which fatal results have followed its taking is said to be two hours, the average perhaps being eighteen to twenty-four, and death has resulted from the taking of something less than a half-ounce.

Treatment.—Treatment is similar to that of poisoning by sulphuric or nitric acid.

Postmortem Appearances.—The postmortem appearances resemble very closely those found after death from sulphuric or nitric acid, the mucous membrane in the upper passages being grayish in color, while the ridges of the stomach are blackened, resembling a similar condition produced by sulphuric acid. The mouth, throat, and œsophagus present a condition of softening, shredding, and denuding.

Tests.—Hydrochloric acid, like the alkaline chlorides, is a natural constituent of the stomach contents. The strong acid is distinguished from other acids by the white fumes given off with the vapor of ammonia, by its yellow color, by its giving off chlorine when heated with magnesium peroxide, and by its power of dissolving gold when combined with nitric acid. A dilute acid is recognized by the formation of silver chloride when a small amount of a solution of silver nitrate is added. This precipitate darkens on exposure to light, is insoluble in boiling nitric acid but soluble in ammonia. As the acid is volatile the materials to be tested,

such as the contents of the stomach or viscera, may be put into a glass retort together with a small quantity of distilled water and distilled nearly to dryness. Having rejected the first part of the distillate, that which remains should be tested by means of the silver nitrate test already suggested.

Illustrative Cases of Hydrochloric Acid Poisoning.—CASE I. —Thomas (*Australian Medical Journal*, 1891, xiii. 542) reports a case of poisoning by hydrochloric acid in a girl who had taken a large quantity of strong acid. About ten minutes after taking the acid the doctor found her very prostrated, vomiting with great straining, and evidently suffering acutely. She was then able to swallow, drinking about a half pint of milk and bicarbonate of soda, the milk being ejected almost immediately in stringy curds, as was milk with magnesia. A large quantity of mucus, at first clear, but later brown and thick, was also vomited. She had taken the acid about 1.30 P. M., and at 11 P. M. she was unable to swallow, and the voice was very husky, complained of great pain over stomach, and was still vomiting. Expression one of anxiety. Next morning she was able to swallow a little; vomiting had ceased. She complained of great pain in abdomen; eyes clear and bright; asked for something to relieve the pain; abdomen was tympanitic and very tender. Patient died suddenly at 3 P. M.

Postmortem Examination (*twenty-one hours after death*).—The abdomen, and particularly the neck and chest, were emphysematous; lips appeared scalded; brain normal; fauces not examined; trachea contained much yellow-stained mucus; lungs tinged yellow, and emphysematous at edges; about four ounces of blood in thorax; no adhesions. Right side of heart contained tarry fluid; left ventricle soft and uncontracted, and containing bloody froth; about two ounces of fluid in pericardium. The œsophagus contained a large amount of yellowish mucus; the mucous membrane was also yellow in color, and considerably swollen. Externally, the stomach appeared normal, except a patch about four inches square, beginning two inches from the pyloric end of the large curvature, and extending from the anterior to the pos-

terior surface. This patch was perfectly black, and on its anterior surface were three small perforations, and on the posterior there were two about the size of a sixpence. There was slight extravasation into the peritoneum, possibly due to handling. The entire internal surface of the stomach was covered by a layer (a quarter inch thick) of grumous matter, perfectly black. Reaction just turned blue litmus paper red. The duodenum contained a large quantity of bile, but was uninjured. The intestines were normal, but greatly distended with gas. The liver appeared like a fatty liver, both externally and on section; other organs healthy. The spleen not discolored, but slightly enlarged.

CASE II.—Leg (*St. Bartholomew's Hospital Reports*, 1874, x. 230) reports a case of poisoning by hydrochloric acid in a man aged fifty, who was said to have swallowed about three-quarters of a teacupful of the strong acid. On admission to the hospital, about half an hour after taking the acid, his face was haggard and pupils dilated. Tongue white and fauces apparently not much affected. The pulse could not be counted; very small and irregular. There was great pain over the epigastric region, and the extremities were very cold. He was quite sensible. Half an hour after admission the pulse was 112, very small. Bowels acted twice; stool small; no blood; constant desire to go to stool; legs drawn up, and pain in the epigastric region very severe. The pain on swallowing was referred to the thyroid cartilage. Death took place four and a half hours after admission, or about five hours after taking the acid. Toward the end the stools became chocolate colored and smelt of hydrochloric acid. The man vomited only once, about five minutes before death; about a quart of brown grumous liquid was brought up.

Postmortem Examination (*six hours after death*).—Body thin; external jugular vein much distended. The pharynx and tongue whitened; membrane covering pharynx at back was shrivelled and uneven as far as the cricoid cartilage. Below this the mucous membrane of the œsophagus became blackish gray. The submucous vessels were all thrombosed. There were spots, here and there white, beneath the mucous

membrane. On opening the peritoneum it was found to contain a blackish fluid exactly similar to that afterward found in the stomach. There were no signs of peritonitis. The stomach was much distended. The peritoneal surface was of a dark blackish-gray color. The great cul-de-sac was much thinned. On an assistant raising this part, the contents of the stomach, a pint or more, very black, escaped. Many oil-drops floated on the surface. The descending colon over the kidney, on its inner surface, where nearest to the stomach, had its peritoneal coat blackened and a large extravasation of blood near it. The inside of the stomach was deeply black. The blackened mass could not be wiped off. The coats were greatly thinned. The blackening was most marked in the great cul-de-sac. There was a hole here about the size of a half-crown. There was no other. The blackening of the mucous membrane of the stomach ceased about three inches from the pylorus. Here it became gray, dotted with white spots, not removed by washing or scraping. Mucous membrane of duodenum of pale-brown color; intestines cut very crisply. These appearances extended about a yard into the small intestine, gradually ceasing. The rest of the small intestine natural, except that there were spots where the vessels were injected and small ecchymoses had formed. The mucous membrane of the large intestine was ecchymosed throughout. The spots were as large as peas. Contents of the alimentary canal markedly acid. Lungs highly emphysematous. The left pleura over the diaphragm blackened where near to the stomach. The blackening extended a short distance into the lung. Heart and aorta natural. Liver very pale; structure very indistinct. From the cut surface a good deal of blood flowed. Cut edges did not become everted. Kidneys and spleen natural.

Microscopical Examination.—The liver was hardened in spirit and thin sections showed an astonishing number of very large oil-globules; many of these were twice the size of the largest liver-cell seen in health. Very few liver-cells could be distinctly made out, and in many places only fat-

drops were to be seen. The stomach was hardened in spirit and thin sections made. In very few places could any epithelium be made out; the thrombosed vessels appeared to run close to the free surface, the submucous connective tissue being laid quite bare, and no trace of the mucous membrane was detected. All the vessels in the submucous and many in the muscular coat were thrombosed. No change in the muscular coat could be seen. In the upper part of the small intestine nothing more could be made out than some thrombosis of vessels in the submucous tissue and an immense number of goblet cells.

POISONING BY STRONG ALKALIES.

Three of the strongest alkalies, potassium, sodium, and ammonia, in their concentrated and caustic form, simulate in their action the effect of poisoning by the caustic acids. The disorganization and destruction of the tissues with which they come into contact are similar to the effect of the acids, and the symptoms of poisoning by this means are also much like those from acids.

Potassium is usually **found in commerce** in the form of potassium hydrate or caustic potash, usually cast in moulds in the form of thin sticks. These are crystalline in character and deliquesce readily, absorbing water. It is a strong alkali, and is readily soluble in alcohol or water. In its stick form it is a strong caustic.

Sodium hydrate or caustic soda is a white crystalline body usually found in the form of cylindrical sticks. It dissolves readily in water and alcohol, and deliquesces as does the potassium hydrate.

Ammonia, when pure, is a colorless, highly pungent gas with a specific gravity of 0.59. The aqua ammoniæ of commerce is a concentrated solution of this gas. Its vapor is poisonous, and when inhaled may cause death from the irritation set up by it in the air-passages.

Caustic soda and potash are commonly found in commerce under the names of potash, pearl ash, and soda-ash.

Ammonia in solution is commonly known as hartshorn. Suicidal and homicidal poisoning by any one of the three is comparatively rare. On account of the pungent odor of ammonia it would not be supposed that it could be taken by accident, and yet it frequently has been, and patients suffering from the effects of accidental poisoning from ammonia are commonly treated at hospitals.

Symptoms.—The symptoms presented in cases of poisoning by potash and soda are so similar that one description will do for both. There is burning pain during swallowing, and an acrid, caustic taste. If the fluid penetrates to the stomach, there is persistent burning pain. Vomiting may or may not occur. When it does, the vomitus will usually be brown in color; it may or may not contain blood, and will simulate very closely in appearance that found after the taking of any of the strong acids.

Ammonia presents rather more violent symptoms in proportion to its strength than does potash or soda, and on account of the irritating quality of its fumes symptoms due to its inhalation are very marked.

Dose.—The fatality of a dose of any of the three alkalies depends rather upon its concentration than upon the amount taken. Death may occur within a few hours, and may be due either to distinct poisoning or to suffocation as a result of swellings about the throat and glottis.

Treatment.—Neutralize the alkali by giving dilute acids. Oils which form soap with these alkalies may be of benefit, and the administration of soothing fluids, such as barley-water, milk, or albumin-waters, may give some relief. When ammonia has been inhaled, it has been stated that the inhalation of the vapor from acids may have some effect in neutralizing the alkali. A stomach-pump should be avoided on account of the weakened condition of the œsophagus and stomach.

Postmortem Appearances.—The mouth, throat, œsophagus, and stomach will be stained brownish or black. The mucous membrane and other tissues are more or less disorganized according to the strength of the solution. When

the poisoning has been less violent in type and death occurs more slowly, ulcerations may be found extending even into the intestine.

Tests.—The characteristic soapy feeling and frothy appearance of materials with which caustic soda or potash has come into contact will be noticeable. Soda and potash may be detected in the form of carbonates, or otherwise by evaporating the suspected liquid to dryness and then heating the residue in a porcelain vessel sufficiently to char the organic matter. In the ash so remaining potash and soda may be detected by the ordinary tests for these substances. When burnt in a colorless flame potash will give a violet color and soda a distinct yellow.

Ammonia may be more difficult to recover from the suspected material on account of its high degree of volatility, and it must be further appreciated that during the process of fermentation or decomposition ammonia is given off in very considerable quantities. It may be distinguished from the other two alkalies, potash and soda, by its great volatility and its extremely pungent odor. This odor will persist in the stomach and intestines for hours or days after its ingestion if the body be not opened. Ammonium carbonate may be distinguished from the other solid alkaline salts by its odor, its high degree of volatility, and the effervescence which takes place in the presence of an acid.

Another simple test, when the ammonia is not strong, is the deep sapphire color which is produced by the addition of any of the salts of copper.

Illustrative Cases of Potassium Hydrate Poisoning.—CASE I.—*Deutsch. med. Ztg.*, Berlin, 1857, xxvi. 229) reports a case of poisoning by soap-lees, which at a specific gravity of about 1.33, contained 30 per cent. of caustic potash. The patient was a man, aged fifty-five, who drank a portion of a glass of soap-lees. It was calculated that he had taken about a half ounce of caustic potash, of which a fourth part was considered to have reached the stomach. He was seen almost immediately. The mucous membrane of the mouth and throat was of a bluish-red color, was separating in shreds,

and easily bled on being touched. He complained of an insupportable burning pain, extending from the mouth to the stomach, a nauseous taste, and a sensation of constriction in the gullet. He could not swallow, every attempt inducing constriction of the fauces. Choking and an inclination to vomit existed, but he did not completely vomit. There were constant coughing, cold perspiration, with paleness of the face, collapsed features, slight convulsions, hiccough, and a rapid, small, thready pulse. Abdomen was distended and tender to the touch. The taking of liquids excited vomiting of bloody shreds of mucous membrane, and caused great pain. In eight days the inflammation was reduced and he went into the country, and was not seen again until six weeks afterward. At this time there was still difficulty in swallowing, which he referred to the cardiac region. He had become weak and his countenance was expressive of deeply seated suffering. The difficulty in swallowing increased and he died from inanition twenty-eight weeks after swallowing the alkali.

Postmortem Examination.—Excessive emaciation existed. Nothing abnormal was found in the fauces and upper part of the œsophagus, but the latter became thicker and more contracted as it descended to the stomach. The thickness increased, so that at the cardia it lay in a roll-like form at the upper part of the stomach, measuring in places two inches in diameter. The interior of the tube had undergone a corresponding infundibular diminution, so that the cardiac aperture would scarcely admit a crow-quill. The increase in thickness was entirely confined to the mucous membrane, the folds of which were obliterated and its epithelium unusually developed and softened. The muscular coat had well nigh disappeared, some thin, pale, scattered, circular fibres only remaining. No induration or ulceration. The stomach was empty, small, contracted, and bloodless, but free from any organic degeneration.

Case II.—Hadden (*Trans. Path. Soc.*, Lond., 1890, xli. 86) reports a case of poisoning by caustic potash in a man who swallowed several ounces. When seen a few days after

taking, his mouth and pharynx were charred and greatly swollen. Rather more than a week after taking the fluid a cast of the entire œsophagus was expelled, which on examination was found to consist of the altered mucous and submucous coats, with some of the circular muscular fibres. Gradual inability to swallow supervened, and it was clear that contraction was taking place. He died three months after taking the fluid; but in spite of the narrowing of the gullet he was able the day before his death to swallow some fluid. During all the time he was under observation there was no hæmatemesis or melæna, but he expectorated large quantities of viscid mucus mixed with pus.

Postmortem Examination.—The whole interior of the œsophagus was irregularly ulcerated, and in many spots the circular muscular fibres might be discerned. The entire canal was diminished in capacity by the cicatrization of the ulcerated surface, but the extreme narrowing affected the pharynx on a level with the base of the epiglottis, above the upper opening of the larynx. The pharynx here was scarcely more in diameter than a cedar lead-pencil. Stomach not affected. The cast consisted of a long slough, which took in the entire length of the tube, as well as of the lowest part of the pharynx.

Illustrative Cases of Sodium Hydrate Poisoning.—CASE I.—Hofmann (*Atlas Legal Medicine*, Phila., 1898, Plate 31) mentions a case of poisoning by caustic soda, in a man aged twenty-one, who swallowed a large quantity of a so-called solution of sodium hydrate (about 40 per cent. sodium hydrate). He became immediately ill with symptoms of violent gastro-enteritis; he vomited blackish masses, and revealed on examination a swollen mouth. He died at the end of two days.

Postmortem Examination.—The body was markedly congested and the entire mucous membrane of the mouth was swollen. The epithelium was in part separated from the underlying structures; in part it was still attached in the form of soft, white, turbid shreds. The epithelium was absent from the mucous membrane of the entire œsophagus.

The mucous membrane itself was softened throughout, swollen, markedly congested, and of a brown color increasing in intensity below. The stomach contained coffee-colored, turbid liquid. The mucous membrane was similar in appearance to that of the œsophagus. The epithelium was also absent from the mucous membrane of the stomach. The discoloration was especially marked at the crests of the rugæ, at which situations fading ecchymoses and small superficial areas of loss of substance were also to be noticed. The mucous membrane was injected and showed in places hemorrhagic infiltration. The submucous cellular tissue was œdematous. The blood in the vessels was coagulated, but the coagula were soft. The mucous membrane of the duodenum was relaxed, and showed slight imbibition of bile, but no other changes.

CASE II.—Casper (*Forensic Medicine*, vol. ii. p. 112) reports a case in which the **postmortem examination** showed that "the blood in the body had no alkaline reaction, but a perfectly peculiar brownish-red color almost like Malaga wine. And not only was the body (all except the lungs) remarkable for its anæmic condition (explicable by its putrefied state), but what blood was in it seemed to be almost wholly coagulated in fibrinous clots. Chemically investigated the blood was found to be neutral, its somewhat alkaline reaction being obviously due to the process of putrefaction. The trachea, beneath its bronchial division, was already of a chocolate-brown from putrefactive imbibition, but in its upper portion and in the larynx there were very evident signs of inflammation, but no contents. Both lungs were hyperæmic and excessively œdematous; the right displayed a considerable amount of recent hepatization, particularly in its upper lobes. The flabby heart contained a few of the brownish-red clots described. The œsophagus and fauces as well as the tongue and lips displayed nothing abnormal. The stomach was apparently as firm as usual, not softened, still less perforated, but rather displayed externally only the usual hues of putrefaction. Its mucous membrane was, however, completely softened, its fundus already beset with putrefactive bullæ, but amid the hues of putrescence we could still distinctly

recognize the dendritic injection and scarlatinous redness of inflammation. No erosion could be discovered. The inflammation did not extend into the duodenum, still less into the lower parts of the intestine. The anæmic liver and kidneys displayed a dirty grayish-red appearance, which was probably due to the peculiar color of the blood."

Illustrative Cases of Ammonia Poisoning.—CASE I.—Hancock (*Medical Chronicle*, Manchester, 1891, xiv. 107) reports a case of acute ammonia poisoning in a man aged thirty-nine. He took about an ounce of strong ammonia. He was seen a few minutes later by a physician who passed a stomach tube, and after evacuation of the stomach administered some olive oil, and sent him to the hospital. He swallowed the poison at about 6 P.M., and was admitted to the hospital at 10.45 P.M. At this time he was suffering from a burning sensation in the mouth and throat, with considerable difficulty of breathing, and much hoarseness. Pulse was rapid (120), but the respirations were not much increased in frequency. No pain in the stomach. He was rather restless and during the night he vomited once or twice, bringing up milk and a little blood. The next morning his general condition seemed a little better, though he complained of his throat and breathing being very bad, and he was very hoarse.

Physical Examination.—Face wore an anxious and distressed expression. No pain in the stomach. Burning pain in the throat and mouth, difficulty in breathing, hoarseness, and pain in swallowing. Examination of the chest revealed nothing abnormal beyond evidence of slight bronchitis. Mouth revealed several isolated patches and spots where the epithelium had been eroded on the dorsum of the tongue, as well as on the palate and uvula. These patches were of a bright-red color, and had a very angry appearance. The palate and uvula were pale and œdematous. The pillars of the fauces were greatly congested, and there was some congestion of the pharynx. The larynx was examined, and on the first examination the rima glottidis was seen merely as a linear slit between two large and prominent masses—the excessively swollen aryteno-epiglottidean folds. Two other attempts

were made to obtain a view of the larynx, but failed, owing partly to the irritable state of the inflamed palate and uvula, and partly to the accumulation of secretion in the throat; and some spasm supervening, he sank back in a condition of urgent dyspnœa. Tracheotomy was performed and respiration was restored for the time being. He went on fairly during the afternoon. For the next two days his pulse was from 120 to 150; respirations 24 to 34; temperature 100° to 102° F. He had great difficulty in swallowing and a constant sensation of burning in his mouth. Restless and irritable. He seemed to be getting on satisfactorily, and there was no evidence of any pneumonia upon careful examination of the chest. On the third bay after admittance to the hospital he suddenly pulled out the whole of the tracheotomy tube. No serious result ensued, the opening remaining fairly patent. Tube was replaced and tied in. During the night his temperature rapidly rose to 103.8° F. In the morning it rose to 104.2°; pulse 150; respiration 48. He died at 9.30 A. M., eighty-seven hours after taking the poison.

Postmortem Examination.—No staining around the mouth, but slight erosion of the lips. Heart and pleura normal. Lungs crepitant in all parts, but markedly congested and œdematous. Slight erosions at the back of the tongue. Fauces, particularly the left, congested and slightly swollen. Epiglottis very congested and eroded. Interior of larynx congested, swollen, and aperture of the glottis almost obliterated. The trachea was congested; mucous membrane was much swollen, but there were no distinct erosions. No peritonitis; a little blood in the pelvis. Stomach and duodenum presented a dark reddish-brown color. The surrounding mesentery and omentum also were stained deeply red. Upon opening the stomach some dark, reddish-brown semifluid material mixed with mucus was found; the walls of the cardiac end were swollen, thickly corrugated, and of a dark amber-brown color; other parts of the stomach, duodenum, and jejunum were congested. Liver showed postmortem decomposition along its border; section revealed congestion

and slight fatty changes. Spleen congested. Pancreas soft, otherwise normal. Kidneys small; capsule non-adherent; surface showed prominent veinlets; upon section, cortex and medulla much congested. Bladder contracted and markedly congested.

CASE II.—Monro and Workman (*Glasgow Medical Journal*, 1898, l. 343, case of D. M'F.) report a case of poisoning by gaseous ammonia in a man aged thirty-four, who was exposed to the fumes of ammonia gas for a considerable time. He was admitted to the hospital on the afternoon of the 17th, conscious, but suffering from severe dyspnœa. Conjunctiva was injected, and the fauces, uvula, etc., had a raw appearance. The epithelium was gone from part of the soft palate; over another part it adhered as a white membrane. The alæ nasi moved freely in respiration. Percussion over chest was normal, but the volume of respiratory murmur was much diminished. Pulse, 110; respiration 28; temperature 101° F. There was a burning sensation in the throat and some difficulty in swallowing. The breath had a strong ammoniacal odor. Toward midnight the temperature rose and the dyspnœa became very distressing. Next day he complained of pain in the chest in front and back, and of severe burning in the mouth and throat. The sputum had a slightly rusty tint. Urine acid, trace of albumin, no sugar or blood; urates deposited. On the 19th, numerous fine moist râles were detected at both posterior bases. In the evening of the 19th the patient was greatly distressed. His pulse remained strong until near the close, when he collapsed suddenly, and died at 5.45 A. M., on the 20th. The temperature was irregular and generally febrile, ranging from 101° to 103.8° F.; pulse 80 to 110; respiration 18 to 36.

Postmortem Examination.—There was much livid congestion of the face and dependent parts. The conjunctiva was much congested, and the deeper vessels of the sclerotic appeared injected; there had evidently been also some inflammation of the iris and cornea. On opening the thorax the lungs were found almost free from adhesions and were very voluminous; their borders showed marked emphysema. The

bronchi were deeply congested and lined with a membrane, apparently of fibrinous character, which could be easily stripped off, leaving a raw, inflamed surface; this condition of the bronchi extended even to the very small tubes, and the trachea and larynx were similarly inflamed and lined with a false membrane. The fauces, back part of the tongue, tonsils, and uvula presented a raw, inflamed appearance which extended down to just below the opening of the larynx; the rest of the mucous membrane of the œsophagus presented a healthy condition; but the stomach, especially toward the cardiac end, showed congestion, of moderate degree, in patches. Heart and pericardium were normal. Liver, pancreas, and spleen appeared healthy. Kidneys appeared acutely congested. Sections of the lungs revealed a very evident and remarkable bronchopneumonia which had been produced by the irritant. Death appeared to have been caused by asphyxia due to this bronchopneumonia.

POISONING BY ALKALINE SALTS.

POTASSIUM NITRATE.

Potassium Nitrate (Nitre, Saltpetre, KNO_3) is found in nature and is also manufactured for use in medicine and in the arts.

Properties.—When pure, it occurs as colorless transparent six-sided prisms, odorless, having a cooling, saline, and pungent taste and a neutral reaction; is soluble in water and almost insoluble in alcohol. It is used for many purposes in the arts, perhaps most largely in the manufacture of gunpowder. It is also an antiseptic. When externally applied in concentrated form it is a strong irritant, and has sometimes been used as a stimulant or counterirritant. In dilute solution it may be given in quite large amounts, but when concentrated it is extremely poisonous.

Dose.—When in dilute solution 1 or 2 ounces have been taken in divided doses within twenty-six hours without apparent toxic effects, but from concentrated solutions death

has occurred in many instances from a dose containing 6 drachms to 1 ounce.

The rapidity of death will depend largely upon the form in which it is given. Taylor reports a case in which death took place in three hours from 1 ounce taken by mistake for Epsom salts.

Symptoms.—The symptoms are those produced by any of the strong irritants: burning and pain in the mouth, throat, and stomach; vomiting associated with bloody stools; cold, moist skin; rapid pulse; collapse, sometimes preceded by convulsions or paralysis. If life persists for a considerable length of time, suppression of urine usually occurs.

Treatment.—There is no antidote. The treatment should consist of emptying the stomach, administration of bland, soothing fluids, relief of pain, and stimulation.

Postmortem Appearances.—The postmortem appearances will depend largely upon the concentration of the dose. When the solution is sufficiently strong, we may have a very similar condition to that found after the taking of mineral acids or any of the strong alkalies. The appearances vary. There is usually congestion of the upper gastro-intestinal tract. Mucous membranes take on a crimson color. The blood is brighter red than normal.

Tests.—The tests for potassium nitrate are the same as those for nitric acid. After poisoning of this sort, it has been recovered from the urine, kidneys, liver, and spleen. It is largely eliminated through the urine, and may be detected in it in from one to two hours after it has been taken.

Illustrative Cases of Potassium Nitrate Poisoning.—CASE I. —Cassidy (*Canada Lancet*, 1876–77, ix. 108) reports a case of poisoning by saltpetre, in a man aged fifty-two, who took about an ounce of saltpetre by mistake for Epsom salts. He vomited immediately afterward. Complained of pain in the epigastrium, and was purged. He was admitted to the hospital for treatment two weeks after taking the poison. At the time of admission, complained of tenderness in the epigastrium, vomiting, persistent headache of the vertex, and constipation. Four days later the man appeared very dull

and heavy and complained of his head. There was also incontinence of urine; slept very little and was constantly moaning. On the sixth day after admission his pulse was 154, respiration 50, temperature 103°F.; comatose with stertorous breathing. He died at 8 P. M. of this day, six days after admission to the hospital and about twenty days after taking the poison.

Postmortem Examination.—The heart was adherent to the pericardium, and was enlarged, weighing eighteen ounces; no valvular lesions were present. The stomach contained a quantity of dark-greenish turbid liquid. The mucous membrane was very red over a large portion of the greater curvature, and in the centre of this reddened portion was a gangrenous patch about the size of a quarter. On examining the brain a portion of the surface about the size of a quarter showed marks of recent inflammation. The surface of the convolutions, at this spot, was much roughened. There was no effusion. The inflamed spot was situated beneath the articulation of the superior angle of the occipital bone with the parietal bones. The rest of the brain was healthy.

CASE II.—Littlejohn (*Edinburgh Medical Journal*, 1885, xxxi. 102) reports a case of poisoning by nitre in a child about three years old. After taking the nitre the child was cold and vomited repeatedly. The bowels acted, and before the child could be somewhat warmed and put to bed it purged four times. He died two or three hours after taking the nitre.

Postmortem Examination.—Head: the brain and its membranes were much congested. Mouth, etc.: nothing unusual was observed in the mouth, throat, or upper part of gullet. There was slight congestion of the mucous membrane at the lower end of the gullet where it joined the stomach. The windpipe presented a normal appearance superiorly, but from about the middle of the trachea down to its smallest subdivisions in the lungs it was much congested. Chest: the contained organs (with the exception of the congestion of the trachea) were healthy in structure. The right cavities of the heart were distended with dark fluid blood, the left were

empty and contracted. Abdomen: on opening the stomach it was found to contain about half an ounce of clear very viscid mucus possessing no particular odor. The whole internal surface of the stomach was of a bright cherry-red color, which depended on the effusion of blood into the mucous and submucous coats. There was no ulceration, and the peritoneal surface presented a normal appearance. The small intestines were much corrugated and congested on their external surface. About four feet of the upper portion of the small intestines were removed and opened. The mucous membrane was generally of a light pinkish hue, and was covered with a grayish-yellowish tenacious mucus. The large intestines appeared healthy, and were contracted and empty. On being opened, their mucous surface presented similar appearances to those noted in the small intestines. No feculent matter was found in the body. The rest of the abdominal organs appeared to be healthy. On analysis, nitre was detected in the mucus lining the stomach and intestines, in the liver, lung, kidney, brain and in the blood.

POTASSIUM CHLORATE.

Potassium Chlorate ($KClO_3$) is usually produced by the action of chlorine gas on a solution of caustic potash.

Properties.—When pure, it is in colorless prisms or plates, permanent in the air, odorless, with a saline taste and with a neutral reaction. It is soluble in something less than twenty parts of water, slightly soluble in alcohol.

Uses.—On account of the tendency to explosion which may take place during its mixture with any of the sulphates or phosphorus, it is not used in the manufacture of gunpowder. It has been used for bleaching, and is largely used in medicine.

It is eliminated largely through the saliva and kidneys. On account of this first fact it has been freely given in cases of stomatitis and other affections of the mouth and throat, the idea being that, on account of its free elimination through the mucous membranes, the drug would be constantly in contact with the irritated and inflamed surfaces. It is used

externally in various inflammatory conditions of the genito-urinary tract and also as a dressing for ulcers. It is more irritating than most of the other salts of potassium, and when used internally for a considerable time may result in irritation and congestion of the stomach, intestines, and kidneys.

Dose.—When in concentrated solution doses of from ½ to 1 ounce have proved fatal.

Symptoms.—When taken in sufficient quantity, it acts as a violent irritant to the gastro-intestinal and urinary tracts, producing vomiting, purging, and great prostration. The urine may be found to contain blood and casts. Nervous symptoms, such as weakness, rigidity of the muscles, convulsions, delirium, and coma, are frequently found. The skin is usually jaundiced.

Treatment.—There is no chemical antidote. The treatment should be the emptying of the stomach, stimulation, and the relief of pain.

Postmortem Appearances.—The blood will be found more or less chocolate-colored on account of the destruction of its pigment, the gastro-intestinal tract congested and inflamed, the kidneys markedly congested, and urine containing blood.

Illustrative Case of Potassium Chlorate Poisoning.—Peabody (*Medical Record*, N. Y., 1888, xxxiv. 57) reports a case of poisoning by chlorate of potassium, in a girl aged twenty, who had taken two tablespoonfuls of the salt by mistake. She was admitted to the hospital at 4 P. M., on the day following the taking of the poison. She was in a condition of profound prostration. Temperature was 99° F., pulse 136, respiration 32. Surface was very cyanotic, her face being nearly purple in hue. No attempt was made to wash out the stomach, inasmuch as fourteen hours had elapsed since she had taken the poison, and she had vomited freely. Her breathing, though rapid, was not labored, and there was apparently no subjective dyspnœa. After she had been put to bed she lay usually quiet, but at times she would become quite restless, tossing about in bed and rolling from side to side. After a short period of restlessness she would again subside into a quiescent condition. Her pulse, though not

very rapid, was very feeble, and it was thought necessary to resort to pretty active stimulation. She had vomited much prior to her admission to the hospital and was nauseated when she was brought there, and vomited abundantly a bile-stained fluid after her arrival. At 6 P. M. her temperature had arisen to 104° F.; her pulse and respiration were not materially changed. During the night her bowels moved three times, the feces being always of a dark-brown color and of semisolid consistence. Urine was passed involuntarily; this also had a very dark chocolate color. A few ounces of urine were obtained by catheter. It presented a similar appearance. It contained many blood-cells and large masses of altered hæmoglobin, and much albumin. The next morning her temperature had fallen to 99.4° F.; respiration and pulse had diminished in frequency and improved somewhat in character. By noon this improvement in pulse had disappeared and her heart was again profoundly weak. At 3 P. M. her temperature had again risen and was 101.2° F. Oxygen was freely given without any resulting improvement. Dr. Peabody saw her at this time and was very much impressed by the very extraordinary color of her skin and conjunctivæ and lips, as well as by the very great restlessness which she manifested. The combined effects of intense anæmia with a cyanotic hue apparently beneath the surface, together with a very distinct sepia-brown or chocolate tint where the epidermis was thin, produced a most remarkable and unusual effect. She was at this time very restless, and constantly tossing about the bed Her pulse was perceptible at the wrist, but was so feeble that it could with difficulty be counted. She grew rapidly weaker, her respirations increased in frequency, and, though they were deep and full, and though she was inhaling pure oxygen, there was no relief of the dyspnœa and no improvement in her color. She slept steadily after this time and died quietly thirty-seven and a half hours after taking the poisonous dose.

Postmortem Examination (*twenty-five minutes after death*). —Body presented the appearance of a well-nourished young woman. Rigor mortis was absent. There was some œdema

of the legs. The color of the body was not materially changed by death, except that the cyanosis of the surface was less marked, and with the subsidence of the blood from the surface there appeared a slight hue of jaundice added to the anæmia and chocolate color. The site of the application of the mustard paste, the epigastrium, was exactly marked out by subcutaneous hemorrhage. Instead of being merely bluish, it was of bluish-brown color. The abdominal and thoracic muscles were of a very dark-red color. The blood in the vessels of the neck and in the great vessels was all liquid, and of a very dark chocolate color. The clots in the heart were very soft and friable and of the same color as the blood in the vessels. The heart was soft and flabby. There was slight dilatation of the left ventricle, and fat was to be seen in the papillary muscles which control the mitral valve. The valves were competent and size of heart normal. The lungs were structurally normal, but their cut surfaces were very brown in color. The spleen was large, firm, and of a very distinct chocolate color. The kidneys were large, capsules not adherent, surfaces smooth and of a chocolate color. Both kidneys were found to be diffusely stained with the same chocolate-colored blood. The blood in the brain was found to present the same appearances as the blood found elsewhere; but the brain and membranes were structurally normal. The stomach contained a pint and a half of a thick dark-colored fluid with a distinct admixture of bile; structure normal. The solitary follicles were large, and Peyer's patches were pigmented; but otherwise the intestines were normal. The liver was normal in size; it was chocolate-colored, but not so dark-colored as some of the other organs. The bladder contained three ounces of urine, which was of a dark, brownish-black color and very untranslucent.

By **microscopical examination** the chief lesions of importance were found in the heart and kidneys. Very extensive fatty degeneration was evident in the heart. Many of the straight tubes in the pyramids of the kidneys were found filled, even to being distended, with broken-down blood-cells and methæmoglobin. The distention was often so great as to flatten the

epithelium beyond recognition; elsewhere the epithelium was not altered in appearance. A spectroscopic examination of the blood revealed the spectrum of methæmoglobin with great distinctness.

POTASSIUM BITARTRATE.

Potassium Bitartrate (Cream of Tartar, Argol, HC_4O_6) is naturally produced during the fermentation of wines, especially those which are acid. During fermentation this material is deposited in the casks, the red wines forming a reddish crust, and the white wines a white one. It is the result of tartaric acid acting upon the caustic potash, and is usually associated with calcium tartrate and coloring-matter.

Potassium bitartrate occurs in white masses of crystals which are always powdered before being sold. It is soluble in 210 parts of water, very slightly soluble in alcohol. In medicine it is a cathartic and diuretic, and is frequently used as a cathartic in combination with other drugs.

Dose.—When in concentrated solution death has resulted within forty-eight hours from the taking of 2 ounces.

The **symptoms** produced are similar to those of potassium nitrate, and the treatment consists in emptying the stomach and the use of mucilaginous drinks, stimulants, and the control of pain.

Postmortem Appearances are similar to those of potassium nitrate.

Tests.—When heated, the salt chars and gives off inflammable vapors having the odor of burned sugar. It is dissolved in a warm solution of caustic potash, and is precipitated by hydrochloric acid, sulphurated alum, aluminum and potassium sulphates.

Illustrative Cases of Potassium Bitartrate Poisoning.—CASE I.—Roger (*Fried. Bl. f. ger. Med.*, 1887, xxviii. 196) reports the case of a man, aged thirty-three, who took 200 grammes of cream of tartar, which was partly dissolved and partly suspended in water; from the effects of which he died in twelve hours. Symptoms were not obtained.

Postmortem Examination.—The mucous membrane of the stomach was of a uniform black-red color over the entire fundus, which changed to a coarse network upward and to an arrangement of parallel lines toward the lesser curvature. Between these markings the mucous membrane was evenly pale red, and marked with a great number of minute punctiform and stellate, bright-red spots. The mucous membrane of the duodenum was uniformly pale red, with numerous bright-red spots. A similar appearance was noted in the small intestine, where there were also numerous almost microscopic white dots.

CASE II.—Tyson (*London Medical Gazette*, 1837–38, i. 177) reports a case of poisoning by cream of tartar in a man aged thirty-seven, who had taken nearly a quarter of a pound of the drug. He was seized with violent vomiting and excessive purging. He complained of pain in the umbilical region and of great thirst. Tongue brown and dry; pulse feeble; pain in the loins. Thighs and legs appeared paralyzed. The fluid vomited was of a blackish-green color, and the motions of a coffee-ground color. Death occurred about forty-eight hours after taking the poison.

Postmortem Appearances.—Stomach was distended with gas, and contained about three ounces of a thick brown fluid, colored apparently with bile. The mucous membrane of the stomach and duodenum was found highly inflamed, the cardiac portion of the stomach being of a deep-red color, with some spots of black extravasation. The whole of the intestinal canal was more or less inflamed. The mucous membrane of the rectum was injected in small streaky red patches; where there was no redness the membrane was of a white color. The intestine contained a thick brownish kind of mucus.

ALUM.

Forms.—The name alum has been applied to two salts, one, **ammonium alum**—aluminum tersulphate combined with ammonium sulphate; the other, the same salt of aluminum associated with potassium sulphate. The latter form, or

potassium alum, is that which is of importance to the toxicologist. It is found in nature completely formed, and in so-called alum ores which contain most or all of its ingredients. It is usually seen in large colorless octahedral crystals taking on a whitish coating on exposure to air, odorless, with a sweet, astringent taste and an acid reaction, soluble in water, insoluble in alcohol.

Potassium alum is used more or less largely in medicine and is a powerful astringent with irritating qualities. It has been used internally to relieve flatulence and given in moderate doses as a cathartic; it has been used in intestinal dyspepsia combined with opium and camphor. Its most common use, however, is in the treatment of various forms of sore throat and for the control of hemorrhage.

Dose.—Death has occurred from a dose of 1 ounce.

Symptoms.—Alum is a gastro-intestinal irritant, and gives rise to the burning pain, vomiting, and diarrhœa commonly associated with such irritants.

Treatment.—There is no chemical antidote. The treatment, like that of the other irritants, consists of emptying the stomach, the giving of mucilaginous and bland drinks, stimulation, and the relief of pain.

Postmortem Appearances.—In a case reported by Recquett there was found a greenish-yellow coating covering the mucous membrane of the mouth, larynx, and œsophagus; the tongue and fauces were swollen; the stomach, bowels, and kidneys were injected.

Tests.—A solution of alum in water dissolves zinc and iron with the evolution of hydrogen. If ammonia-water is added to a solution of alum, a bulky white precipitate is formed, nearly insoluble in an excess of ammonia; if a solution of potassium or sodium is added, a white precipitate is formed which is completely soluble in an excess of the alkali.

Illustrative Case of Alum Poisoning.—Hicquet (*Annales d'Hygiène publique*, Paris, 1873, xxxix. 192) reports a case of poisoning by alum in a man aged fifty-seven, who took about 30 grammes dissolved in a glass of water. He had a feeling

of constriction and burning in the mouth, throat, and stomach; nausea interrupted by one fit of vomiting; no movements of the bowels; extreme discomfort, then unbearable anguish. Pulse small and frequent; respiration quick; repeated syncope. Mental state not affected. The next morning the patient was in a desperate condition; pulse intermittent and wiry; skin cold; swallowing almost impossible. Death occurred eight hours after taking the alum.

Postmortem Examination.—Decomposition slight, rigor mortis absent. Bluish discoloration of the cutaneous veins of the thighs. Mucous membrane of the mouth, pharynx, and œsophagus covered with a grayish-yellow coating and easily detached. Tongue and tonsils swollen. An effusion of coagulated blood was observed between the trachea and œsophagus and in front of the thyroid cartilage. Peritoneum inflamed throughout; the cavity contained considerable brownish serous fluid. Omentum injected; its veins and those of the mesentery full of black blood and hard. External surface of the stomach grayish and strongly injected; veins full of black blood, which was hard and friable, as though due to the action of acids or astringents. Mucous membrane gray and shrivelled; at the pyloric end disorganized and inflamed. The contents of the stomach consisted of a brownish fluid, which attacked the surface of the scalpel; near the pylorus was an amount of gray powder. The organ was somewhat contracted. Duodenum thickened, contracted, and of a gray color; in its upper part was more of the gray powder. Notable injection of both the large and small intestine. In the first half of the small intestine were two oval gangrenous spots measuring ten and fifteen centimetres in the long diameter. No well-marked alteration in the large intestine; the descending colon contained some semi-solid fecal matter of a greenish-brown color. Liver small, grayish, and hard; its peritoneal coat covered with a fibro-albuminous exudation of a yellowish-gray color. Liver substance anæmic. Kidneys much injected. Lungs normal; pleural cavities contained considerable bloody serum. Chemical examination of the stomach and intestine proved the

poisonous substance to be potash alum, which had probably calcined.

POTASSIUM SULPHATE.

Potassium Sulphate (K_2SO_4) is a secondary product in the distillation of nitric acid from a mixture of nitre and sulphuric acid, in the manufacture of potassium bichromate, and in several other processes. It is also found in nature in kainite, which is a double sulphate of potassium and magnesium combined with magnesium chloride. It is used somewhat in the arts and quite largely in medicine.

Its physiologic action, when in small doses, is that of a mild purgative not associated with pain. In larger doses up to ½ ounce it is a slow but active purge. It occurs as colorless, hard, six-sided, rhombic prisms, permanent in the air, odorless, having a saline, slightly bitter taste and a neutral reaction, soluble in water, not in alcohol.

Dose.—In medicine it is ordinarily given in doses of from ½ to 6 drachms as a cathartic. In doses of from 1 to 2 ounces it is a powerful irritant and has caused death. The same may be said of any of the so-called purgative salts. Cases have been reported of death following 2 ounces of Epsom salts. Sodium chloride when taken in large amounts has also been followed by fatal results.

Symptoms.—The symptoms following poisoning by potassium sulphate are those of any gastro-intestinal irritant: vomiting, pain, more or less abdominal distention, and collapse.

Treatment.—There is no chemical antidote, and treatment consists in washing out the stomach, relieving pain, and the administration of stimulants.

Postmortem Appearances.—The postmortem appearances are those of gastro-intestinal irritation. The mucous membrane of the stomach and intestinal tract is found congested, with possibly small hemorrhages into it. If the dose was a large and concentrated one, hemorrhage to a considerable extent may have taken place into the stomach.

Tests.—If recovered in a solid form, it is not difficult to recognize on account of the characteristic form of its crystals.

From the solution containing it potassium and sulphuric acid may be discovered by their appropriate tests.

Illustrative Cases of Potassium Sulphate Poisoning.—CASE I.—Bayard and Chevallier (*Annales d'Hygiène publique*, Paris, 1842, xxvii. 397) report a case of poisoning by sulphate of potassium in a woman aged twenty-five. She had taken six doses of 100 grains each at intervals of fifteen minutes. Immediately after taking the first dose she was seized with pain in the stomach, nausea, vomiting, and cramps in the legs and arms. These symptoms were aggravated after taking each dose. She suffered from severe purging and dyspnœa, and died within two hours after taking the first dose.

Postmortem Examination.—Rigor mortis very pronounced and the jaws were contracted. Abdomen greatly distended with gas. Lips blanched and colorless. Mucous membrane of the mouth was dry, ecchymotic, and showed slight signs of ulceration. Pharynx and œsophagus were pale and bloodless. The cardiac part of the œsophagus was injected and at the entrance to the stomach there was an ecchymotic spot covering a space of two centimetres. Stomach: mucous membrane was pale with the exception of several small slate-colored spots. The greater curvature was generally emphysematous, and in particular a spot of about 5 centimetres in extent. Toward the pyloric end various emphysematous blisters were found in both the mucous membrane and in the muscular coat. The stomach contained 60 grammes of a thick reddish fluid, in which were numbers of grayish flakes. On analysis this fluid was found to contain sulphate of potassium. Intestines: mucous membrane was pale, soft, thin, and in an emphysematous state, with the exception of the valvulæ conniventes, which were of a reddish color. A pulverized, grumous substance was found adhering to the walls of the intestine. On analysis sulphate of potassium was found in the fluid contained in the intestine. There was effusion of blood into the lungs. Serous effusion into the pleura. The integuments of the skull were pale and dry. Meninges injected. Cerebral substance pale but without signs of congestion.

CASE II.—Christison (*On Poisons*, Philadelphia, 1845, p. 507) mentions the Haynes' case of poisoning by sulphate of potassium, in which a woman was given two doses of one ounce each on two successive evenings. She was seized after the first dose with excessive and alarming sickness, from which she soon recovered without apparent harm; but after taking the second dose she had violent vomiting and profuse purging, of which she died in five hours without any alteration in the symptoms, except that she became insensible for five minutes before death.

Postmortem Examination.—The whole of the gastro-intestinal mucous membrane was bright red. Stomach empty, but highly inflamed. The vessels of the brain were much congested, and between two and three ounces of blood had escaped from the neighborhood of the occipital sinus.

CHLORINATED POTASH AND SODA.

Chlorinated Potash and Soda (Bleaching Salts, known in commerce as Javelle Water and Labarraque's Solution, respectively) are closely similar in **character, preparation,** and **action,** excepting that sodium carbonate is used in the preparation of one, and potassium carbonate in that of the other. They have been used extensively as disinfecting and cleansing agents. The **U. S. P. standard solution** is described as a clear, pale-greenish liquid, with a faint odor of chlorine, a disagreeable alkaline taste, and an alkaline reaction.

It is used in medicine externally in the treatment of foul ulcers, and is sometimes used internally in the treatment of fetid intestinal irritation. In cases of asphyxia from sulphuretted hydrogen gas it is a rather effective antidote. When in fairly strong solution it is an antiseptic, disinfectant, and was formerly used as a deodorizer.

Dose.—Ten to 30 drops have been used well diluted. Externally, when diluted, 1 to 15 or 20, it is usually unirritating. A number of cases of poisoning have been reported, and under such conditions the symptoms will depend to a large extent upon the concentration of the dose.

Symptoms.—When given in concentrated form, the symptoms will be those presented by any other gastro-intestinal irritant.

Treatment.—The treatment will be that already suggested for other irritants of the same class.

Postmortem Appearances.—The postmortem appearances following the taking of either of these solutions will be similar to but rather more pronounced than those found after the other salts of potassium. In a concentrated form it is an active irritant, a strong alkali, and in addition to the irritation found in poisoning from any other of the potassium salts we have that due to the chlorine gas.

Tests.—When hydrochloric acid is added to the solution, there is a marked effervescence with evolution of chlorine and carbonic acid gases, and a solution is formed which is not precipitated by platinic chloride if potassium is absent; if it is present, there will be a precipitate.

Illustrative Case of Chlorinated Potash and Soda Poisoning.—Tardieu (*L'Empoisonnement*, Paris, 1867, 267) reports a case of poisoning by chlorinated potash and soda in a boy aged eight, who took accidentally a quantity of eau de Javelle. There was immediate vomiting of mucus streaked with blood; acute pain at the base of the neck, and he was constantly craving food. Swallowing was very painful, and only a small quantity of food could be taken at one time, and it was rejected immediately. The child lost flesh rapidly, and was admitted to the hospital about two months after taking the poison. At this time he was considerably emaciated, and could scarcely eat. On swallowing, violent pain was felt on a level with the sternum and food was rejected immediately. He improved somewhat and his parents removed him from the hospital, but brought him back in nine days. During this time there had been a considerable change. Emaciation was extreme. There was profuse perspiration; stools were liquid and very abundant. Urine was dark and slightly albuminous. On examination of the neck a small tumor was made out. Tumor was not painful. Fever set in; pulse frequent, depressed, 140. Skin hot and dry at

first, and then moist with profuse perspiration. He died from inanition, the result of stricture of the œsophagus, three and a half months after taking the poison.

Postmortem Examination.—Extreme emaciation. Muscles are soft and flabby. Œsophagus: at a distance of two centimetres from the cricoid cartilage began a considerable narrowing. External circumference measures two and a half centimetres. This narrowing extends to within a short distance of the cardiac orifice. The walls were considerably thickened. The calibre is very narrow and will barely admit a probe. Mucous membrane is thickened and shows signs of old ulceration in the form of almost annular cicatricial bands, resembling in appearance the rings of the trachea. These bands are white, hard, resistant, and the mucous membrane is slightly ulcerated in circumscribed spots. This condition extends the whole length of the stricture. Below the stricture the mucous membrane is healthy. Stomach small in size; walls are hypertrophied and the folds of the internal surface look very angry. The mucous membrane is healthy. The other organs of the body are healthy.

SALTS OF BARIUM.

Barium occurs in nature in the form of baryta, and in the so-called vein-stone. It is obtained from one of these sources or from the native sulphate, and is used in the arts, especially in water-color painting. The chloride is used in medicine to a very limited extent.

Dose.—Death has occurred from less than 100 grains of the chloride and from 60 grains of the carbonate in periods of from seventeen hours to three days.

Symptoms.—All of the salts of barium, with the exception of the insoluble sulphate, are active irritant poisons. The symptoms produced by the chloride and carbonate are very similar, and quite like those produced by potassium nitrate. Sharp, burning pains in the stomach and bowels, vomiting and purging, great prostration, dimness of vision, ringing in the ears, pain and throbbing in the head, etc.

Postmortem Appearances.—The postmortem appearances are similar to those of potassium nitrate.

Tests.—The only two salts, so far as is known, which have caused death are the chloride and the carbonate. The chloride occurs in rhombic tables with bevelled edges. It is soluble in water and somewhat in alcohol, and has a bitter, disagreeable taste. It does not deliquesce. The powdered salt burnt upon a platinum wire in a smokeless flame gives a greenish-yellow color. A solution of the chloride when treated with sulphuric acid or an alkaline sulphate gives a white precipitate which is insoluble in nitric acid. Barium carbonate is a white powder insoluble in water, and dissolved by dilute hydrochloric acid with effervescence of carbonic anhydride. If this solution is evaporated to dryness, the crystals of barium chloride (see above) will be found.

Illustrative Cases of Barium Poisoning.—CASE I.—Ogier and Socquet (*Annales d'Hygiène publique*, Paris, 1891, xxv. 447) report a case of poisoning by barium chloride in a man, who took about 20 grammes of the salt in mistake for magnesium sulphate. There were violent vomiting and diarrhœa almost immediately after taking the poison. In spite of all treatment he died four and a half hours after the ingestion of the barium.

Postmortem Examination.—Lungs were slightly congested. The cavities of the heart contained a small amount of coagulated blood and of liquid blood which was of a blackish color and of a pitchy consistence. The stomach contained 75 c.c. of a brownish liquid; and the mucous membrane was swollen and ecchymosed in places. The kidneys were congested. Mucous membrane of intestine was healthy. Intestine contained a small amount of fluid material. No congestion of brain or meninges.

On **analysis**, free barium chloride or converted barium sulphate was found in appreciable quantities in the intestine, liver, kidneys, spleen, lungs, and in the heart's blood; but only a trace of the barium sulphate was found in the stomach.

CASE II.—Tidy (*Med. Press and Circular*, London, 1868, vi. 447) reports a case of poisoning by nitrate of baryta in a

man aged forty-six, who took a quantity of the drug by mistake. The inside of his mouth was covered with blisters. There were a partial loss of voice, coldness in the extremities, intense pain in the bowels, a burning pain in the throat, partial convulsions, with violent vomiting and purging. He died in a state of collapse about six hours and a half after taking the mixture.

Postmortem Examination.—"Muscular rigidity well marked. The membranes of the brain were congested, the vessels being fully extended with dark colored blood. The left pleura was adherent, the left lung being very much congested, the right slightly so, especially at the edges. The heart was large and flabby, both sides full of black blood. The duodenum was highly congested; there were several dark, congested spots about the rectum. On opening the stomach it was noticed that in some parts there was merely a slightly increased vascularity, the redness in other parts being of a very much deeper character. Ramifying over its entire surface, there were observed vessels filled with dark blood, which were more marked and in greater number near the pyloric end. This general florid appearance extended to that portion of the duodenum which was attached to the stomach. The stomach contained about four and a half ounces of a reddish fluid which had a neutral reaction. The small intestine throughout its whole length presented a slightly, though very slightly congested appearance. The rectum was highly congested."

QUESTIONS.

Describe poisoning by irritant poisons.
By sulphuric acid.
By nitric acid.
By hydrochloric acid.
By caustic soda.
By caustic potash.
By ammonia.
By potassium nitrate.
By potassium chlorate.
By potassium bitartrate.
By alum.
By potassium sulphate.
By chlorinated potash and soda.
By salts of barium.

CHAPTER III.

SPECIFIC IRRITANTS.

NONMETALLIC PHOSPHORUS.

PHOSPHORUS in various combinations is a normal constituent of the body. It is found in small quantities in the urine, and from its first discovery in 1669 until 1769 it was prepared by a secret process from the urine. While it occurs in nature in other combinations, it is largely prepared by the action of sulphuric and hydrochloric acids upon bones, whether in their fresh, calcined, or disorganized state.

Properties.—It occurs as a semitransparent, wax-like, solid, colorless or slightly yellow substance, without taste, and it is luminous in the dark. When perfectly pure, there is no color. It melts at 44° C., has a specific gravity of 1.83, is insoluble in water and slightly soluble in alcohol. When exposed to the air, it gives off white fumes which are luminous in the dark and have an odor similar to garlic. It crystallizes in rhombic dodecahedra.

It occurs in two allotropic forms, one yellow, the other dark red, the latter of which is called amorphous. These differ decidedly in most of their properties; the amorphous being insoluble in carbon disulphide, is not luminous or poisonous. Phosphorus is largely used in the manufacture of matches and vermin poisons. It is used in medicine to a small extent, more especially as a stimulant to the nervous system.

Poisonings with phosphorus, either accidental, suicidal, or homicidal, are not at all uncommon, and may be either acute or chronic. Chronic forms of phosphorus-poisoning are common among those who work in it, and the well-known phosphorus necrosis which so commonly affects the bones of the jaw in phosphorus-workers is well recognized.

Accidental poisonings, especially in children, from sucking or eating the heads of matches, are not uncommon, and fatal results have followed in children even from the small amount found on two matches.

Dose.—Phosphorus is generally used in medicine in doses of from $\frac{1}{100}$ to $\frac{1}{30}$ grain; but even in such small doses it is rather uncertain in its action, and in some individuals this amount will give rise to more or less serious symptoms. A case has been reported in which death followed the taking of about $\frac{1}{10}$ grain; $\frac{1}{2}$ grain has caused death in many instances. Its effect in moderate-sized doses where death is due to its specific action is rather slow, and even after the taking of a fatal dose life usually persists for one to six or eight days. Where a large dose has been taken and death is apparently the result of its locally irritating action, it has followed within one-half hour. Death may occur from chronic poisoning after a lapse of months or years.

Symptoms.—Phosphorus is a violent, irritant poison, but symptoms do not usually follow until some time after the poison has been taken. There are violent pains in the throat and stomach, with thirst, nausea, vomiting and purging, dilated pupils, and signs of great prostration. The urine is diminished and contains blood. If life persists for several days, jaundice usually follows. Phosphorus may be detected in the vomited matter, which is also luminous in the dark, and is usually green or of a coffee-ground color. Death may occur either in a few hours or be delayed several days. If life persists, its action upon the nervous system may be demonstrated by paralysis, muscular twitching, etc. In cases of chronic poisoning the symptoms are similar but more insidious. This may occur either from the taking of repeated small doses in a solid form, or from the inhalation of the vapors of phosphorus during the manufacture of matches.

Treatment.—There is no satisfactory chemical antidote. The oil of turpentine has been suggested, and it is said that the French acid turpentine of European commerce is effective, forming with it a crystalline spermaceti-like mass, which is soluble in ether, alcohol, and the solutions of alkaline salts, is not poisonous, and is eliminated by the kidneys in an unchanged condition. It has been pointed out that copper forms with phosphorus a phosphide, which is black, insoluble, and nonpoisonous. Bamberger recommends its use in dilute

solution, 3 grains every five minutes, until vomiting is induced. It should, however, be remembered that copper sulphate in these doses is a marked irritant itself, and that if the phosphorus has been taken in a large, concentrated dose, copper sulphate given in irritating doses would be more apt to set up increased irritation than to allay that already present. The treatment, in a general way, should consist in emesis, saline cathartics, perhaps small doses of copper sulphate, and the treatment of symptoms as they arise. *Fatty oils should not be given, as phosphorus is readily soluble in them, and their taking would tend to increase rather than to decrease the absorption of the poison.*

Postmortem Appearances.—On opening the body, especially the stomach, after the ingestion of a large and concentrated dose, the odor as a rule is characteristic. If the dose is sufficiently large and little time has elapsed, there may be a distinct phosphorescent vapor arise. The first effect of the phosphorus, when taken in a large, toxic dose, is irritation and inflammation of the gastro-intestinal tract. The congestion will be more or less diffused, and if the dose were a concentrated one, there may be patches scattered over the stomach where the mucous membrane has been destroyed. The blood, which has been described as dark and fluid, does not become red on exposure to air. When death occurs immediately, or soon after the taking of a large concentrated dose of phosphorus, the symptoms presented will be those already spoken of, closely simulating the effects of the other stronger irritant poisons. When, however, life is prolonged for days or weeks, more typical characteristic appearances will be present; the most marked is fatty degeneration of the organs and voluntary muscles. Acute fatty degeneration of the various organs, including the walls of the arteries, is usually found, most typical in the liver. This is of a deep-yellow color, alternating with reddish-yellow patches, and presents the appearances found in cases of acute yellow atrophy of the liver. The skin will be sallow and jaundiced in appearance, partially due to a destruction of the red blood-globules by the phosphorus. On section of the muscles, if

sufficient time has elapsed, fatty infiltration will be found and degeneration of the various muscles will be marked. Caspar reported the case of a woman who died while taking phosphorus medicinally, and it was noted that all of the organs were luminous, indicating the diffusion of this poison by absorption. In certain cases of poisoning by phosphorus there may be marked muscular contraction and rigidity, in others there is practically no muscular change. Putrefaction after death from phosphorus poisoning is always slow.

Tests.—When in the pure common yellow poisonous form, it has a solid, waxy consistence, and a peculiar odor resembling garlic. It is rare when found in this form or in solution, that the characteristic odor and taste may not be perceived. In daylight in fairly concentrated form it emits a white vapor and in the dark it is luminous. It melts and takes fire at a temperature of 112° F., burning with a bright-yellow flame. It is insoluble in water, but is soluble in alcohol, ether, chloroform, and oils, most markedly so in a solution of carbon disulphide. Even in fairly small amounts it may be removed from the contents of the stomach by carbon disulphide. If this solution be allowed to settle and freed from the organic materials, and then allowed to evaporate spontaneously, the phosphorus will appear in small globules or beads, which when tested give the characteristic appearances of phosphorus. The vapor of phosphorus blackens silver nitrate. If the phosphorus is in too small quantities to be detected in a solution of carbon disulphide, the whole mass may be distilled, when the fumes will appear luminous in the dark and will blacken silver nitrate.

Marsh's Test.—A slight modification of Marsh's test for arsenic produces similar conditions.

Illustrative Cases of Phosphorus Poisoning.—CASE I.—Stevenson (*Guy's Hospital Reports*, London, 1877, xxii. 449) reports a case of acute poisoning by phosphorus in a child aged five years, who drank some "phosphorus paste," about 1 P. M. on July 21. No poisonous symptoms appeared for some time, for the child went to school later in the day as usual, and in the evening complained

of "stomach ache" only. On the morning following (22d) about 7 o'clock she was sick, vomiting some "slimy" fluid, and the mother noticed that the child's breath smelt like the empty jar which had contained the paste. The child was sent to the hospital at 9 A. M., and an emetic was administered, which acted freely. When admitted into the clinical ward at 10.30 A. M., the patient was in a state of semi-collapse. Respiration 28, quiet; pulse 140, small, feeble, and regular; temperature 99.5° F. Heart-sounds normal. Pupils dilated, equally respondent to light. The breath smelt slightly, as was supposed, of sulphur. No jaundice. Bowels not acting. About 2 P. M. she appeared to be drowsy, had a dark areola round the eyes, and the pulse was feeble. She took some milk, but vomited it directly. At 9 P. M., temperature 98°; pulse 128, small; respiration 28, tranquil. Did not complain of pain. On the next day (23d) she was restless and drowsy during the night. Bowels not open. Took milk freely but vomited it almost directly. At 10.50 A. M., temperature 97.7°; pulse 132, small, thready; respiration 26, grunting. Thirsty, restless, and very dark round the eyes. Soon after 7 P. M. she became very restless and delirious. No jaundice. The patient died at midnight fifty-nine hours after taking the poison, having been convulsed before death, the fingers being firmly flexed and the legs drawn up.

Postmortem Examination (*fifteen hours after death*).—Brain congested and healthy. Heart: several small patches of ecchymosis on the posterior part of the right side. Muscular walls of normal thickness, but greatly affected with fatty degeneration, which was most marked in the left ventricle. Valves healthy. On the external surface of the arch of the aorta near its origin there was an ecchymosed patch. Stomach contents thick, pulpy, like half-digested food; no smell of phosphorus. Surface of mucous membrane thickly coated with a tenacious mucus, which was with difficulty scraped off. The mucous membrane was considerably injected along the lesser curvature and the anterior and posterior surfaces. No abrasions or ulcerations. Small intestine much con-

gested, especially the upper part. Liver weighed 26 ounces; it was very yellow, and presented all the characteristics of an extremely fatty organ. The surface was for the most part injected, but here and there this condition was absent; and then the yellow color contrasted strongly with the bright red of injection. On section the yellow color was well marked, the appearance of lobules being to a great extent lost. The liver tissue burnt readily in the spirit lamp, but did not float on water. The tissue was itself anæmic. Kidneys were healthy, but somewhat congested.

Case II.—Treves (*Lancet*, London, 1892, i. 1439) reports a case of necrosis of the upper jaw, with chronic abscess of the brain, the result of chronic phosphorus poisoning. A dipper in a Scotch match factory was admitted into the London Hospital on Oct. 11, 1892. Aged forty-nine years, but had the appearance of being much older. He was thin and anxious looking. He had worked at his trade for thirty years without suffering any inconvenience therefrom until nine months previous to admission. The symptom complained of was a toothache in the right upper jaw, which troubled him continuously for four months. He then had some decayed teeth removed. Shortly after, the gum tissue sloughed off the jaw, part of which became exposed. On May 9 some dead bone was scraped away, which gave him some relief. Gradually, however, the necrotic process spread and a very offensive discharge, previously slight, caused him much distress during the interval between the month of May and the time of his admission into the hospital. For six months previous to admission he complained continually of severe headache in the frontal and occipital regions. He could bear no hard covering on his head, so he always wore a soft cloth cap. The headache was almost constant and prevented him from sleeping. His pupils were normal. On Oct. 14 Treves operated. The sequestrum was found to include the whole of the right upper jaw, below the level of the infraorbital foramen, and was bathed in pus of the foulest description. From the 11th to the 23d the temperature was never high; it varied from 97.6° F., as the lowest point, to

99.8° as the highest, being usually about 99°. Until Oct. 23 he appeared to be doing well; his headache had almost gone, he slept well and was very cheerful. At 3 A. M. on the 23d, eight days after the operation, it was found that he had become unconscious. The temperature had risen to 104°. He was irritable and restless and kept groaning and putting his hand to his head. Heart, lungs, and abdomen showed no signs of disease; no motor or sensory paralysis. Oct. 24, temperature between 99° and 100° F.; pulse 84, full but compressible; respiration easy, equals 32; knee-jerk slightly exaggerated on both sides with ankle-clonus. Some twitching movements had been noticed in the left hand. 25th, he had become more apathetic during the last twenty-four hours. He was passing his urine and feces under him; no vomiting; pupils contracted, equal, and respond slightly to action of light; cheeks puffed in and out with respiration, but no stertor; respiration 28 and diaphragmatic; pulse full, but easily compressed, 108; skin warm; sweating freely on head and face; right palpebral fissure wider than left, the eyelids being partially closed; fundi normal, except for some enlargement of veins. His condition had become desperate, and his skull was opened over the right motor area with a two inch trephine, and a small trocar and canula passed into the right hemisphere without result. He died an hour after the operation.

Postmortem Examination.—The pleura, larynx, trachea, and bronchi were normal. In the upper lobe of the left lung at the lower margin was an abscess the size of a Spanish nut with a slightly developed capsule. There were a few ill-defined reddish nodules in the posterior part of the lower lobe (bronchopneumonic). No morbid change of any importance was discovered in any other of the viscera. Brain: diffuse, purulent meningitis of base, less extensive over vertex. At the apex of the right temporosphenoidal lobe was a small encapsulated abscess, close under the cortex. It was evidently of long standing. Both lateral ventricles were filled with pus. In the right ventricle the ependyma was distinctly thickened and of a greenish-red color. The

suppuration was evidently not recent. The brain tissue around the right ventricle was softened and numerous punctiform ecchymoses were seen. In the left ventricle gelatinous greenish pus was found, but there was no thickening of the ependyma and the brain around was normal. The rest of the brain was healthy. The right cavernous sinus was occupied by a softening and stinking clot. On removal of the brain the foramen rotundum was found to admit a cedar pencil and to lead into a large space from which the greater part of the superior maxilla had been removed. The edges of the enlarged foramen rotundum were necrosed and grayish in color. The parts of the superior maxilla remaining and also the body of the sphenoid were grayish and necrosed.

CASE III.—Casper (*Forensic Medicine*, vol. iv. p. 101) reports a chronic case in which *forty-eight hours after death*: "A slight amount of cadaveric stiffening was still present; the abdomen was green from putrefaction. Over the small curvature of the stomach the veins coursed like livid red cords (symptom of putrefaction). The stomach itself diffused no odor of phosphorus; no part of its mucous membrane was either softened or corroded; but on the fundus, as well as about the middle of the small curvature, there were many isolated hemorrhagic effusions crowded together, each about the size of a pin-head; the upper patch was about one inch and a half, and the under one about a half inch in circumference. The stomach contained about six to eight ounces (imperial) of a bright, bloody-looking fluid, mingled with coagulated milk. Particles of phosphorus could not be detected in the stomach even with a magnifying glass. The intestines were pale and displayed nothing abnormal either externally; the large intestine contained feces. The blood was dirty-red, of a syrupy consistence. The liver was hyperæmic, the gall-bladder half full. The spleen was very full of blood. Both kidneys were already somewhat brownish-red, from commencing putrefaction, and remarkably hyperæmic. The urinary bladder was of an extraordinary livid color, and contained about a tablespoonful of milky urine. The vena cava con-

tained only a small amount of blood. The lungs were beautifully marbled, contained but little blood, but exhibited a well-developed hypostasis. In the pericardium there was a tablespoonful of bloody serum. The heart was almost completely empty; the large bloodvessels, however, contained much blood. The larynx and trachea were empty, and their mucous membrane had not the dirty-brown color of putrefaction, but was of a bright purplish-red, with a fine linear vascular injection clearly distinguishable by the aid of a glass. The œsophagus was empty and quite normal. The meninges were moderately congested, and the brain contained more blood than usual; the plexus choroidalis was livid, the individual parts of the brain were normal, and the sinuses almost empty."

IODINE.

Iodine is found very generally diffused in nature, more especially in sea-water, marine plants and animals, from which it is largely obtained. It has also been detected in the ashes of tobacco, beet-root, potatoes, beans, peas, wheat, barley, oats, in oysters and eggs, and in various spring-waters, fresh, salt, and mineral. It is obtained commercially at present either from ashes of marine vegetation or from the native sodium nitrate or Chile saltpetre with which it occurs.

Properties.—Iodine when pure is a bluish-black friable substance, occurring in crystalline scales or rhombic plates of a metallic lustre, with an odor somewhat like chlorine, a sharp, acrid taste and a neutral reaction. It is slightly soluble in water, soluble in alcohol, and very soluble in ether, chloroform, glycerin, and carbon disulphide. It is volatile, and evaporates with considerable rapidity even at ordinary temperatures. When concentrated, it is irritating whether in its solid, gaseous, or liquid form. It is used in the arts and medicine.

Its **physiologic action** depends upon its concentration. When in strong solution, it is a very decided irritant, is rapidly absorbed, and readily gives rise to poisoning. It is excreted by the skin, the urine, and the saliva. It has been

found in the urine within thirty minutes after taking a single dose, and after such a dose may still be detected at the end of twenty-four hours. It is very largely used as a counter-irritant in the form of tincture. It is also used as an injection when, as in hydrocele, hemorrhoids, etc., a local irritation and inflammation are desirable.

Iodine has been used internally for many years in connection with diseases of the glandular system. It is never given in the solid form internally, but as a tincture, on account of the probability of poisoning. It is also used combined with potassium iodide in the form of Liquor Iodi Compositus or Lugol's Solution (potassium iodide, 2 parts; iodine, 1 part; water, 17 parts), in doses of from 5 to 15 drops. The injection of iodine into the various cavities of the body for therapeutic uses has in a number of instances been followed by poisoning. The amount of iodine necessary to cause death varies largely with different individuals: 2½ drachms of pure iodine have been taken without serious effect.

Symptoms.—Iodine, whether taken in concentrated solution or in diluted form, is a strong irritant and causes the ordinary symptoms of **acute poisoning** in the stomach and intestines, such as vomiting, which may be associated with blood, diarrhœa, and pain. When the vomited matter contains starch in any form, the characteristic blue color will appear; under other conditions it will be more or less yellow. Giddiness, faintness, and convulsions are not uncommon. In the **chronic form of poisoning** the symptoms are somewhat similar to those of phosphorus, but fatty degeneration is not nearly so marked.

Treatment.—Emesis and catharsis are indicated. There is no definite chemical antidote, but, on account of the affinity of iodine for starch, farinaceous liquids and foods have a favorable action.

Postmortem Appearances.—The conditions found after death from iodine poisoning will depend, as is the case with most of the other irritants, to a large extent on the concentration and the form in which it is given. If the dose is a concentrated one sufficient to cause death in a short time, we shall have a condition in the œsophagus, stomach, and intestines

very similar to that found after taking any of the alkaline salts. If there be starch in the stomach or intestine, the characteristic blue color, taken together with the odor, will be in itself sufficient ground on which to base a diagnosis. The more remote effects will also depend on the concentration of the dose and the time during which life persists. Fatty degeneration of the liver is marked, and the same condition will be found in the other organs, including the heart and the muscular coats of the arteries.

Tests.—The most commonly used and the simplest depends on the blue color which iodine gives to starch in any form. This test is an extremely delicate one, perhaps the most delicate, and it is said that it will indicate the presence of iodine in 450,000 times its weight in water. In order that this test may succeed, the iodine must be free and the solutions cold. When the iodine is in combination, as it always is in the animal fluids, a little nitric acid, which must itself be free from iodine, should be added to the solution.

The chloroform test is also a very delicate one, and depends on the violet tint which is given to dilute acidulated solutions of iodine on the addition of a few drops of chloroform. It is probable that the starch test is rather more delicate. When the mixture of iodine and starch in water is heated, generally the color fades, and if the heat be not continued for sufficient length of time to volatilize the iodine, the color will reappear when the liquid becomes cool.

Illustrative Cases of Iodine Poisoning.—CASE I.—Mackenzie (*Illustrated Medical News*, London, 1888, i. 169) reports a case of "fatal purpura from iodide of potassium" in an infant aged five months, who was suffering from congenital syphilis. The iodide was a component part of some medicine which was to be given in teaspoonful doses every four hours. It was estimated that the quantity of iodide of potassium taken at one dose was about two and a half grains. At 9 P. M. the first dose was given. About three quarters of an hour later the mother noticed the child's face "turn black" about the mouth and chin, and almost immediately "the eyes (orbits) and lips

gested, especially the upper part. Liver weighed 26 ounces; it was very yellow, and presented all the characteristics of an extremely fatty organ. The surface was for the most part injected, but here and there this condition was absent; and then the yellow color contrasted strongly with the bright red of injection. On section the yellow color was well marked, the appearance of lobules being to a great extent lost. The liver tissue burnt readily in the spirit lamp, but did not float on water. The tissue was itself anæmic. Kidneys were healthy, but somewhat congested.

Case II.—Treves (*Lancet*, London, 1892, i. 1439) reports a case of necrosis of the upper jaw, with chronic abscess of the brain, the result of chronic phosphorus poisoning. A dipper in a Scotch match factory was admitted into the London Hospital on Oct. 11, 1892. Aged forty-nine years, but had the appearance of being much older. He was thin and anxious looking. He had worked at his trade for thirty years without suffering any inconvenience therefrom until nine months previous to admission. The symptom complained of was a toothache in the right upper jaw, which troubled him continuously for four months. He then had some decayed teeth removed. Shortly after, the gum tissue sloughed off the jaw, part of which became exposed. On May 9 some dead bone was scraped away, which gave him some relief. Gradually, however, the necrotic process spread and a very offensive discharge, previously slight, caused him much distress during the interval between the month of May and the time of his admission into the hospital. For six months previous to admission he complained continually of severe headache in the frontal and occipital regions. He could bear no hard covering on his head, so he always wore a soft cloth cap. The headache was almost constant and prevented him from sleeping. His pupils were normal. On Oct. 14 Treves operated. The sequestrum was found to include the whole of the right upper jaw, below the level of the infra-orbital foramen, and was bathed in pus of the foulest description. From the 11th to the 23d the temperature was never high; it varied from 97.6° F., as the lowest point, to

hemorrhagic spots similar to those found on the arms, only more sparsely distributed, and affecting the outer rather than the inner aspects of the limbs. Jan. 6, morning, the child appeared to be sinking. Pulse 148; respiration 9 per minute, and much prolonged. The face remained greatly discolored, and had now in parts a greenish-black, almost gangrenous, appearance. The lips, especially the lower one, were covered with bloody sordes. The patient died at 8 P. M., sixty-eight hours from the onset of the purpura.

Postmortem Examination.—Numerous spots over the chest, abdomen, and legs, elevated, and of a gray color, which, on section, proved to be small subcutaneous abscesses. Ulceration of skin around anus. Purpura of face, with erosion of skin of nose and cheek. From the duodenum down to within about two feet of the cæcum were numerous ulcers, mostly with the long axis directed transversely, with sloughy gray bases, raised margin, and surrounding hemorrhage. In some parts the centre had not yet sloughed. Kidneys pale and lobulated, otherwise healthy. Left suprarenal capsule very large, with tissue surrounding it infiltrated with new growth, and with numerous hemorrhages both into the interior of the capsule and surrounding tissue. Testes large, hard, and nodular. Sections of the testes showed considerable quantity of new growth in body of testis, but still more in epididymis, with hemorrhages. On the left side the change was most marked, and the tunica vaginalis filled with red gelatinous matter. The changes extended for about an inch up the cord. The iliac and inguinal glands on both cords were much enlarged and of a red color superficially. On section they appeared white and gelatinous.

Case II.—Bainbridge (*Medical Times and Gazette*, London, 1861, ii. 669) reports a case of acute poisoning by iodine in a woman aged fifty years, who took an ounce of tincture of iodine by mistake. Two doses of olive oil and large draughts of warm water were administered, and were returned mingled with iodine. "There was no spasm of the throat noticed, but intense burning, as if the uvula was consumed. The fauces were highly florid, and, together with the tip of the

suppuration was evidently not recent. The brain tissue around the right ventricle was softened and numerous punctiform ecchymoses were seen. In the left ventricle gelatinous greenish pus was found, but there was no thickening of the ependyma and the brain around was normal. The rest of the brain was healthy. The right cavernous sinus was occupied by a softening and stinking clot. On removal of the brain the foramen rotundum was found to admit a cedar pencil and to lead into a large space from which the greater part of the superior maxilla had been removed. The edges of the enlarged foramen rotundum were necrosed and grayish in color. The parts of the superior maxilla remaining and also the body of the sphenoid were grayish and necrosed.

CASE III.—Casper (*Forensic Medicine*, vol. iv. p. 101) reports a chronic case in which *forty-eight hours after death*: "A slight amount of cadaveric stiffening was still present; the abdomen was green from putrefaction. Over the small curvature of the stomach the veins coursed like livid red cords (symptom of putrefaction). The stomach itself diffused no odor of phosphorus; no part of its mucous membrane was either softened or corroded; but on the fundus, as well as about the middle of the small curvature, there were many isolated hemorrhagic effusions crowded together, each about the size of a pin-head; the upper patch was about one inch and a half, and the under one about a half inch in circumference. The stomach contained about six to eight ounces (imperial) of a bright, bloody-looking fluid, mingled with coagulated milk. Particles of phosphorus could not be detected in the stomach even with a magnifying glass. The intestines were pale and displayed nothing abnormal either externally; the large intestine contained feces. The blood was dirty-red, of a syrupy consistence. The liver was hyperæmic, the gall-bladder half full. The spleen was very full of blood. Both kidneys were already somewhat brownish-red, from commencing putrefaction, and remarkably hyperæmic. The urinary bladder was of an extraordinary livid color, and contained about a tablespoonful of milky urine. The vena cava con-

cially foul ulcers. Its salts, especially those of potassium, ammonium, sodium, iron, and mercury, are largely used in medicine on account of their influence in controlling the various forms of nervous irritation.

Dose.—Death has in several instances followed the taking of somewhat less than an ounce of the pure drug.

Symptoms.—When in the crude or pure form, or in concentrated solution, its action is similar to that of iodine and the alkaline salts. It is a violent irritant, and is followed by pain, vomiting, great prostration and restlessness, and death usually occurs in from six to twelve hours.

Treatment.—The best antidote is said to be ammonia. Aside from this the treatment should be that of any other case of irritant poisoning.

Postmortem Appearances.—The postmortem appearances are like those presented in cases of poisoning by any of the stronger irritants. When in concentrated solution, inflammation and irritation of the mouth, œsophagus, stomach, and intestines will be found, with marked swelling and reddening of all the tissues.

Tests.—Bromine bleaches vegetable substances as chlorine does, and destroys the color of indigo sulphate. In combination with starch it gives rise to a yellow color. The skin and clothing to which it is applied are colored a deep yellow. In concentrated solution or in its crystalline form an orange color is produced by the addition of strong chlorine in small amounts.

Illustrative Cases of Bromine Poisoning.—CASE I.—Baker (*Medical Sentinel*, 1897, v. 53) reports a case of bromism in a woman aged thirty-seven years, who had been in the habit of taking bromocaffeine in rather indefinite quantities for several years. Her husband bought it by the dozen bottles, and she took it whenever she felt the need of relief from headache, and more recently she had also been using bromide of sodium, helping herself as she felt the need of it for headache and sour stomach. "She has suffered from headache for some time; has some displacement of the uterus; is somewhat pale and emaciated. A case of mild chronic in-

found in the urine within thirty minutes after taking a single dose, and after such a dose may still be detected at the end of twenty-four hours. It is very largely used as a counter-irritant in the form of tincture. It is also used as an injection when, as in hydrocele, hemorrhoids, etc., a local irritation and inflammation are desirable.

Iodine has been used internally for many years in connection with diseases of the glandular system. It is never given in the solid form internally, but as a tincture, on account of the probability of poisoning. It is also used combined with potassium iodide in the form of Liquor Iodi Compositus or Lugol's Solution (potassium iodide, 2 parts; iodine, 1 part; water, 17 parts), in doses of from 5 to 15 drops. The injection of iodine into the various cavities of the body for therapeutic uses has in a number of instances been followed by poisoning. The amount of iodine necessary to cause death varies largely with different individuals: 2½ drachms of pure iodine have been taken without serious effect.

Symptoms.—Iodine, whether taken in concentrated solution or in diluted form, is a strong irritant and causes the ordinary symptoms of **acute poisoning** in the stomach and intestines, such as vomiting, which may be associated with blood, diarrhœa, and pain. When the vomited matter contains starch in any form, the characteristic blue color will appear; under other conditions it will be more or less yellow. Giddiness, faintness, and convulsions are not uncommon. In the **chronic** form of **poisoning** the symptoms are somewhat similar to those of phosphorus, but fatty degeneration is not nearly so marked.

Treatment.—Emesis and catharsis are indicated. There is no definite chemical antidote, but, on account of the affinity of iodine for starch, farinaceous liquids and foods have a favorable action.

Postmortem Appearances.—The conditions found after death from iodine poisoning will depend, as is the case with most of the other irritants, to a large extent on the concentration and the form in which it is given. If the dose is a concentrated one sufficient to cause death in a short time, we shall have a condition in the œsophagus, stomach, and intestines

in a man aged twenty-four years, who swallowed one ounce of bromine. "The immediate symptoms were of spasmodic action of the muscles of the pharynx and larynx, and great difficulty of respiration. This was soon followed by intense burning heat in the stomach, with great anxiety, restlessness, and trembling of the hands. The pulse was rapid, tense, and corded, and the respiration greatly hurried. The stomach was entirely empty at the time of taking the bromine. An unsuccessful effort was made to use the stomach pump; an emetic of sulphate of zinc, and afterward carbonate of magnesia, in solution with albumin, was given, which produced vomiting only when the stomach was distended. At other times there was no nausea or vomiting. The symptoms above described increased in intensity; the hands and the feet became cold, with failure of the pulse, etc., until 2 P. M., when he died, seven and a half hours after having taken the poison."

Postmortem Examination (*seventeen hours after death*).—"On opening the abdomen, the external and anterior surfaces of the stomach were vividly injected, the lesser curvature to a great degree. Near its middle was a softened ecchymosed spot, an inch and a half in diameter; posteriorly were several smaller and similar spots, surrounded by red borders. The external surface of the duodenum was also vividly injected; the mesentery minutely injected, and a portion of it nearest the stomach was stained a deep-yellow color, as were also other parts lying immediately beneath the stomach. The spleen and liver were of normal appearance. The pancreas much injected and deeply stained. The stomach contained four ounces of thick fluid resembling port wine dregs, and exhaling faintly the odor of bromine. Its whole internal surface was covered with a thick layer of black deposit, resembling coarse tanned leather, with intense submucous injection. The lungs were gorged with blood. There were about four ounces of fluid in the pericardium."

CASE III.—Schmalfuss (*Vierteljahrs. f. ger. Med.*, 1889, 1., Suppl., 37) reports a case of poisoning by bromine in a man aged thirty years, who was found dead in circumstances which left no doubt that he had swallowed bromine.

began to turn black." The discoloration of the face rapidly increasing the child was admitted to the hospital. "When seen at 12.30 A. M. the child presented a most remarkable appearance. The whole of the face was swollen and of a purplish-black hue, the eyelids closed and discolored, the lower lips and chin tensely swollen and of a deeper color even than the other parts, while the tongue and mucous membrane, visible through the open mouth, presented a marked contrast, being of a normally bright color. On the cheeks the discoloration was produced by patches consisting of the aggregation of numerous small spots resembling those of purpura. The skin appeared injected with venous blood in spots and stains. On pressure the color could not be altered in the least. The epidermis was not elevated or disturbed in any way. Some of the spots appeared to have lines radiating from them, but this was not very definite. The anterior nares seemed inflamed, swollen, and plugged with mucus. There were a few spots on each upper arm, more evident on the left side. No purpuric spots were detected elsewhere. Scattered over the abdomen and thighs there were about a dozen abortive pustules, not unlike ill-developed smallpox pustules." On Jan. 4, the morning following admission, the face was puffed up, the eyelids and lips greatly swollen. The edges of the eyelids were glued together by sticky exudate. The whole face was of a dark-red (port-wine) color, more pronounced on the nose, lips, and chin than elsewhere. The coloration was not of a uniform degree, for skin of a lighter color appeared through the dark-red discoloration. The appearance was clearly due to extravasation of blood into the skin; it could not be made to disappear on pressure. The anterior nares were greatly discolored, of a slaty-blue color, bathed with a slight purulent discharge; the passage seemed clear. There was a small hemorrhage in the centre of the hard palate. In the skin over the deltoid muscles and upper arms, especially on the outer side, but also on the inner aspect, extravasations of blood were so numerous as to give the arms a mottled appearance. On the thighs and legs were

signs presented will be those of great irritation rather than those of any peculiar action of the chlorine. When taken in strong solution or in solid combination, black eschars will be noted in the mouth, œsophagus, and possibly the stomach, associated with the various other signs of irritation and inflammation.

Tests.—Chlorine may be easily recognized by the strong, irritating odor of its vapor, its color, and its powerful bleaching action.

Illustrative Cases of Chlorine Poisoning.—CASE I.—Sury-Bienz (*Vierteljahrs. f. ger. Med.*, Leipz., 1888, xlix. 345; Witthaus and Becker, 1896, iv. 280) reports a case of poisoning by the inhalation of chlorine gas in a man aged forty years, resulting fatally. The man had inhaled a small quantity of the pure gas. He immediately experienced an inclination to cough, dyspnœa, and a stabbing pain in the chest. He was seen the morning after the accident, which had occurred during the night, suffering from severe dyspnœa and coughing constantly. In the evening he was worse and was sent to the hospital. The next morning the dyspnœa was intense, and coughing, with little expectoration, was almost uninterrupted. He was greatly excited, and spoke with great difficulty. The heart impulse was not detectable, but the heart-sounds were clear. Sibilant râles were heard, particularly to the right and above. Liver dulness was normal. Urine was brown-yellow, clear, and without albumin. The face was cyanosed. The sputum was frothy and bloodless. There was nothing abnormal in the pharynx, and the voice was clear and loud. Toward evening the dyspnœa increased markedly; every respiratory muscle was brought into play; the movements of respiration were short, particularly expiration. There was slight cyanosis and the pulse was very frequent and small. At 10 P. M. he slept quietly; at 10.30 he awoke and threw himself about; the pulse became imperceptible; there were râles in the throat; and he died at 11 P. M., about forty-eight hours after inhaling the gas.

Postmortem Examination.—The most prominent appearances were: rather intense inflammation of the mucous membrane

tongue and portion of the lip, looked as if denuded; painful choking continued for two days and nights, accompanied all the time by copious salivation. The choking felt as if caused by shreds of skin peeling off in various parts of the throat, accompanied by a sharp, smarting sensation." Deglutition was very difficult. On Nov. 22, four days after taking the poison, the fauces were no longer painful, but relaxed and sensitive, the region of the trachea smarting, accompanied by frequent lancinating pain; the voice, which on the first day was merely hoarse, had descended into a fatiguing whisper, which became more laborious up to Nov. 28, and had not improved at the time of reporting the case, on Dec. 5. The eyesight was weak for several days, and the right eyelid was affected by twitching, being spasmodically looped up into festoons; these spasms had not entirely ceased on Dec. 5. The taste was curiously affected, nothing having its proper flavor but sweets. The patient felt herself utterly prostrated, both mentally and physically. Dec. 5, the strength was slowly returning, the throat was somewhat less relaxed, but the aphonia still continued. The eyesight was less strong than usual, and there was still some spasm of the right eyelid.

BROMINE.

Bromine is a liquid nonmetallic element, resembling in many ways chlorine and iodine.

Bromine occurs in saline springs, sea-water, sea plants, and is found in certain spring-waters.

Properties.—It is a volatile liquid, of dark-red color, with a caustic taste and a smell resembling that of chlorine. Its specific gravity is 3.18 at 0° C., and it crystallizes at 7.3° C., boiling at 63° C. It is slightly soluble in water, soluble in alcohol, ether, chloroform, and carbon disulphide. It evaporates with great rapidity. In its pure form it is a violent caustic, and when taken internally acts as a corrosive poison. In this form it has been used in medicine and surgery to some extent as a counterirritant to take the place of iodine; and when diluted, as an external dressing in cases of sepsis, espe-

Jan, 7-07.

CHAPTER IV.

METALLIC IRRITANTS.

ARSENIC.

ARSENIC is a metal which is found in nature usually in combination with various other metals. It is procured largely as a by-product during the smelting of cobalt ores. In nature it may be found not only as a metal, but also as arsenous acid in combination with almost all the other metallic substances. When pure, it is a brittle, crystalline metal of a steel-gray color, and when recently broken is very brilliant in appearance. On exposure to the air it becomes dark and dull. Its specific gravity is about 7.75, and it gives off white vapors with a distinct garlicky odor. It forms two combinations with oxygen, arsenous acid, AS_2O_3, and arsenic acid, AS_3O_5. The former is also known as white arsenic, and is the substance which is usually called arsenic in the arts and medicine, and is that which is of importance in toxicology.

ARSENOUS ACID.

Properties.—Arsenous acid (As_2O_3), when freshly prepared, exists in the form of a transparent white mass which gradually becomes opaque upon exposure to light. In the form in which it is most commonly found in the shops it is white, soft, and powdery, not unlike flour in appearance, but evidently crystalline on examination under a lens. It has very little taste, and for that reason may be readily introduced into food It has very little odor in its solid form, but when sublimed it has a definite odor of garlic. It is soluble in from thirty to eighty parts of water, freely soluble in hydrochloric acid, the alkalies, and moderately so in glycerin. It is used largely in the arts and in medicine, and is the poisonous ingredient in nearly all forms of insect and vermin poisons. Arsenic is normally found in the urine of a large number of people.

validism. Present attack commenced on January 6, 1896, when she was taken ill with influenza, suffering with fever, pains, and vomiting. In a few days these symptoms disappeared, and the patient, although still weak, was so much improved as to be able to leave her bed. She became much worse about February 12, and rather suddenly passed into a somnolent condition, in which she remained for several days; could be aroused to take food, but would quickly relapse into her sleep again." Somnolence with slight variation persisted to March 7, a period of about four weeks, and being called upon to sign some legal documents it was found that she could not correctly write her own name. Upon careful examination it was found that there was a perceptible general muscular weakness, apparently symmetrical; this was shown by her walk, posture, the action of the muscles of the eye, and her speech, which easily tired. There was but little incoordination, slight or no tremors or twitchings, no definite, localized paresis or atrophies, and sensations were normal (except for apparent sluggishness in their perception). She was incapable of mental exertion, becoming easily fatigued, and confusion and absent-mindedness existed. With an effort the patient could for a time become brighter, and more active mentally. There was present some acne on one leg, and a slight peculiar odor to the breath. In speech there was occasional omission of a word; in writing there was either omission or duplication of syllables, and her penmanship was not so legible as usual. This change in writing was a marked one, and on attempting to write her own name she reduplicated one syllable and finished it in unformed letters. This was in marked contrast to samples of neatly and correctly written letters of former months. Pulse 81 and regular. Respiration normal. General emaciation. The diagnosis of bromism was made and the use of the drug was stopped. The later history showed a rapid recovery from somnolence, mental confusion, and dulness, recovery of normal speech and handwriting.

Case II.—Snell (*New York Journal of Medicine and Surgery*, 1850, v. 340, 179) reports a case of poisoning by bromine

local inflammatory symptoms; the second stage by symptoms dependent upon its neurotic effects, such as paresis, palsy of the extremities, epilepsy, tetanus, hysterical affections, mania, and coma. Two of the most characteristic signs of poisoning by arsenous acid are acute pain in the region of the stomach, increased by pressure, and the presence of severe cramps in the calves of the legs. In the famous Maybrick trial much stress was laid upon the absence of these two signs, and in the minds of many medical men their absence was sufficient ground upon which to base a serious doubt of arsenical poisoning. There is frequently suppression of urine, and there may be more or less pain on micturition.

The symptoms described are the common ones, and those which are usually present where a sufficient amount of poison has been given to cause death, but so much depends on the form in which it is given, the condition of the individual, the size of the dose, that it is impossible to lay down any one symptom or group of symptoms which are always present. As it is impossible to base a diagnosis of arsenical poisoning on any group of symptoms, so it is equally impossible to say that because a group of symptoms are absent therefore death was not due to poisoning by arsenic.

Dose.—The fatal dose of arsenous acid will depend very largely on the method of administration and the rapidity of absorption. It is not, to any great extent, a cumulative poison, and while it is stored temporarily in the various organs, it is eliminated with fair rapidity, so that by the end of ten days or two weeks it has probably entirely disappeared. Symptoms of poisoning, usually in the form of irritation of the gastro-intestinal tract, commonly appear after the administration of from $\frac{1}{3}$ to $\frac{1}{2}$ grain. In solution 3 to 4 grains of white arsenic are usually fatal. Death has occurred in an adult after the taking of $2\frac{1}{2}$ grains in the form of Fowler's solution. Some of the chronic forms of poisoning may occur from the effect of small doses continued over a considerable length of time. Cases are reported in which the taking of $\frac{1}{30}$ to $\frac{1}{20}$ grain per day for several weeks gave rise to more or less serious symptoms. Individuals vary largely in

Postmortem Examination (*ninety to one hundred hours after death*).—The odor of bromine was perceptible on opening the abdomen. The external surface of the intestine and peritoneum was coated with a brown-black, smeary mass. The posterior wall of the stomach was entirely absent, only shreds of the pylorus remained, and what was left of the stomach and contents appeared as if burnt. The contents of the small intestine were yellow or orange, and had a distinct odor of bromine. The small intestine had the appearance of having been cooked. At about a half metre from the pylorus the intestine was perforated, and near the opening in the peritoneum was a yellowish mass weighing about 50 grammes and smelling strongly of bromine. Bromine was obtained from the contents of the intestine by means of distillation.

CHLORINE.

Properties.—Chlorine is a yellowish-green gaseous element, a powerful irritant, with a specific gravity of 2.46, slightly soluble in water. It occurs in nature in various combinations, and most commonly in common salt (sodium chloride). It is usually manufactured by the action of dilute hydrochloric acid upon the black oxide of manganese. Its aqueous solution is used in medicine as an antiseptic in cases of foul ulcers and wounds, and in the form of chloride of lime it is used as a disinfectant and deodorizer.

Symptoms.—When applied externally, it has a strong stimulating effect upon open wounds. When inhaled, it acts as a powerful irritant to the air-passages, and exposure for a comparatively short time to its strong vapors may set up irritation, followed by the various forms of congestion and inflammation. When its solution or any combination, as chloride of lime, is swallowed, it acts as a powerful irritant to the gastro-intestinal tract, producing black eschars.

Postmortem Appearances.—When death occurs from inhalation of chlorine gas, it is usually the result either of œdema of the glottis and upper air-passages, or of secondary bronchitis or pneumonia. Under either of these conditions the

most characteristically noted in the stomach and gastro-intestinal tract, and associated with fatty degeneration of the heart, liver, and kidneys. Arsenic seems to have some peculiar affinity for the lining membrane of the stomach and upper intestine, and by whatever means the poison is introduced into the body, whether through the skin, through the lungs, or by enemata, after death the characteristic appearances of arsenical poisoning will be found in the stomach. The conditions found will depend on the size of the dose, the form in which it is taken, and the time which elapses before death. The mucous membrane of the stomach may be found partially detached and covered with mucus, stained with blood and bile, and if arsenic be taken in the form of Paris green or other substances having a distinct and brilliant color, this color may also appear in the contents of the stomach. According to Taylor, the mucous membrane of the stomach "is commonly found red and inflamed in dotted or striated patches and extending between the two apertures; the color, which is of a dull brownish red, becomes brighter upon exposure to the air; at other times it is of a deep crimson hue interspersed with black-looking lines or patches of altered blood. The redness is usually most strongly marked at the greater end of the stomach; in one case it may be found spread over the whole mucous surface, giving to it the appearance of red velvet; in another it will be chiefly seen on the prominences or folds of the membrane. In one instance the coats were thickened and of a gelatinous consistence without any marked inflammatory redness." The stomach usually contains a dark-colored fluid more or less like coffee-grounds in appearance, depending on the amount of blood contained in it. The swelling of the mucous membrane may be confined to local patches, which may contain arsenic embedded in them. There is rarely any ulceration or gangrene of the stomach-wall, and there are but a few instances on record in which ulceration had taken place. Minute localized patches of ecchymosis are not infrequently found. This condition may extend into or even completely through the small intestine, and in many instances a localized irrita-

of the upper as well as the more minute air-passages; marked œdema of the lungs; slight catarrh of the right kidney; severe, acute catarrh of the stomach and of part of the duodenum. There were also found marked emphysema of anterior origin, enlargement of the heart, complete destruction of the right kidney, and chronic catarrh of the bladder. Death was ascribed to cardiac paralysis.

CASE II.—Cameron (*Dublin Quarterly Journal of Medical Science*, 1870, xlix. 116) reports a case of fatal poisoning from the inhalation of chlorine gas in a sailor who had been exposed to the fumes given off from the accidental mixture of sulphate of soda and chloride of lime.

Postmortem Examination (*thirty hours after the body was discovered*).—"Face pale, not livid; pupils dilated; white froth oozing from the mouth and nostrils; the lips blanched and somewhat swollen; the tongue and gums blanched, the latter appearing as if they had been completely bleached. The epithelium was soft, and in some spots gone as in the case of the lips, tongue, gums, and palate. Neck: deep veins very full. Lungs congested, not very dark; the bronchial tubes full of frothy sanguineous matter; the trachea inflamed. Lungs otherwise normal. All the internal venous system full. Heart healthy; left side quite empty; right side full of dark blood. Stomach healthy, as were all the other visceral organs. Stomach was perfectly empty. Head: veins of scalp full; scalp and dura mater uncommonly adherent; surface of the brain and its membrane only slightly congested; sinuses full; substance of brain very firm, and in all respects healthy. On cutting into the ventricles of the brain a very strong odor of chlorine was evolved. During the examination a tube was introduced into the trachea, and pressure having been applied to the chest, a bloody and frothy liquid possessing a slight odor of chlorine was evolved through the tube. No odor of the gas was perceived in the abdomen."

QUESTIONS.

Describe poisoning by phosphorus.
By iodine.
By bromine.
By chlorine.

through the solution. If arsenic be present, there will follow a precipitate of lemon-yellow arsenous sulphide. This precipitate is insoluble in cold hydrochloric acid, soluble in hot acids, and may further be tested by reduction and the formation of a characteristic mirror of octahedral crystals. According to Wormley, this test reacts with $\frac{1}{5000}$ grain of arsenous acid.

Reinsch's Test.—To the suspected fluid is added $\frac{1}{6}$ of its bulk of pure hydrochloric acid. It is then boiled and a piece of copper gauze introduced. Boiling is continued. If arsenic is present, there will be a deposit of pure arsenic on the copper, which will become steel gray or black in color. According to Wormley, by the use of very fine tubes and minute strips of copper, crystals may be obtained from $\frac{1}{50000}$ grain of arsenic. Antimony and mercury will be similarly deposited upon the copper, but the deposit is not crystalline in character either on its first deposition or when sublimated.

Marsh's Test.—Marsh's test is probably the most delicate. According to Wormley, the amount of arsenic in a good stain may not be over $\frac{1}{30000}$ grain, and it would certainly show the presence of $\frac{1}{50000}$. Its disadvantages are that it can not be used in the presence of organic matter, and that it reacts to antimony as well as to arsenic. The stains, however, may be differentiated by several means, so that notwithstanding this disadvantage it is an exceedingly accurate test. This process requires a special apparatus, which must be tested, together with the materials used, in order to demonstrate that arsenic is not present in them, and is tested by allowing the apparatus to produce hydrogen and burn it for some time; then if a piece of cold porcelain is introduced into the flame and shows no stain, the purity of the materials is proved. Marsh's test depends on the generation of hydrogen from pure zinc and pure sulphuric acid in a definite apparatus.

After testing the apparatus and the materials used, the suspected fluid, from which the organic matter has been removed, is introduced through the funnel-tube into the bottle. If arsenic be present, hydrogen arsenide is produced

When given in proper therapeutic doses, arsenic acts as a tonic, especially to the nervous system. It is commonly used in a great variety of conditions, especially in the various nervous diseases and malaria. Externally in the form of pastes, it is used in the treatment of malignant growths of various forms.

Symptoms.—Poisoning by arsenic may be acute or chronic. On account of its wide distribution in nature and its uses in the arts, exposure to the chronic form of poisoning has been in the past very great. When taken internally or externally in repeated small doses a great variety of symptoms occur, depending upon its action as a local irritant to the tissues with which it comes into contact, as well as its action upon the general system, especially the nervous. Acute poisoning from arsenic is more common than that from any other drug. The symptoms produced by the ingestion of a toxic dose are bad taste in the mouth, ptyalism, signs of irritation in the pharynx, larynx, and œsophagus, nausea, weakness, burning pain in the region of the heart, vomiting of material which may contain blood, diarrhœa, fetid and frequently black stools, thirst, together with the signs and appearance of great prostration, itching, and occasionally spots of inflammation upon the skin. In certain cases delirium, convulsions, priapism, and other evidence of irritation of the central nervous system occur. In some cases the symptoms very closely simulate those of Asiatic cholera. In other cases definite symptoms may be almost entirely absent and death occur from exhaustion. Where arsenic is given with homicidal intent during the presence of disease, symptoms of arsenical poisoning may be so controlled as not to be noticeable or considered. Christerson divides cases of poisoning by arsenous acid into three groups according to the violence of the symptoms. In the first class the poison produces symptoms of irritation and inflammation along the course of the alimentary canal, and death commonly comes in from five to six hours. In the second, signs of inflammation are moderate or even entirely wanting, and death occurs in from one to three days. In the third class there are two stages: the first characterized by

second sound of heart; skin cold and clammy. He died early in the morning of the 12th.

Postmortem Examination (*nine hours after death*).—The dependent parts of the body were of a dark bluish color; other parts of the body and limbs were covered with bluish spots, irregular in outline, varying in size from half an inch to several inches in diameter. Scattered over the body were some blackish spots, varying in size from that of a pin's head to that of a pea (ecchymoses). The inside of the mouth and the tongue were covered with deep ulceration. On incision the muscles were seen to be of a bright-red color. There was about six ounces of straw-colored fluid in the abdominal cavity; the peritoneum was everywhere clear and glistening; the intestines were distended with gas. Liver was enormously enlarged, nearly filling the abdominal cavity, and was of a bright-yellow color. There were about eight ounces of dark, bloody fluid in the left pleural cavity; a little less, of a lighter color, in the right. Both lungs were adherent at the top and back. There were about two ounces of straw-colored fluid in the pericardial sac. The pericardium was clear and glistening on its inner surface. There was a little fluid blood in the right side of the heart, and a very small well-organized clot. The left side was empty. The left lung was generally of a dark-red color; the vessels were full of blood; the bronchi were filled with frothy mucus; a quantity of dark bloody fluid could be squeezed from the cut surface. The right lung was generally in the same condition as the left. Trachea contained a quantity of frothy mucus. Œsophagus normal. The spleen was enlarged to twice its normal size, and was of a bluish color. The left kidney was a little enlarged, and of a uniform bluish color; its capsule was adherent. Section showed the bloodvessels to be moderately full of fluid blood; the cortical portion was of a reddish-gray color, normal in thickness; the tubular portion was of a bluish color, and the vessels in it could be seen as red lines. The right kidney was slightly larger than the left, and like it, with the exception that the cortical portion was of a grayish-yellow color, and the vessels could be seen in it as well as in

their susceptibility, and for this reason it is customary to begin with small doses and increase gradually. The case of a young adult has been reported in which 6 or 7 drops daily of Fowler's solution proved fatal at the end of five weeks. It is possible for an individual to establish in himself the ability to take very large doses, and cases are on record in which several grains have been taken daily without producing any symptoms.

Fatal Period.—The period at which death follows the ingestion of a poisonous dose of arsenic varies greatly in different cases. It has occurred within two hours and it has been delayed up to sixteen days after the taking of a large quantity. In this last case, although it was known that a large quantity of arsenic had been taken, at the postmortem examination no trace of it could be discovered in the body. Arsenic is eliminated by means of the urine, bile, skin, and probably the large intestine. It has been discovered in the urine within three quarters of an hour after the dose was taken, and, according to certain observers, has persisted for many weeks and even months. These last cases, however, are open to doubt, as the amount discovered at the end of months was very slight, and it is not infrequently found in the urine of those who, so far as is known, have not taken arsenic.

Treatment.—The nearest approach we have to a chemical antidote is the "Ferri Oxidum Hydratum cum Magnesia," which is an officinal preparation. If the patient is seen within a few minutes after the poison is taken, there is probably no objection to the use of the stomach-pump and the washing out of the stomach. On account of the softening of the tissues which follows quite rapidly this proceeding is a dangerous one when attempted after the lapse of any considerable time. Emetics, such as zinc sulphate and mustard, may be used better after the administration of large quantities of milk. Beyond this the treatment largely depends on the control of symptoms, by the use of mucilaginous drinks, opium, etc.

Postmortem Appearances.—The appearances found after death from poisoning by arsenic in any of its forms are

poisoning the patient's eyesight became affected. He could see only in the recumbent position. Attempts to sit up would result in attacks of syncope. This disposition to syncopal attacks lasted about a day and a half, and then deafness came on, which lasted about three days. There were continual tinnitus aurium and hemorrages from the ear, followed by the discharge of pus. The ringing in the ears persisted for six weeks, then ceased, first in one ear and four days later in the other. On the fourth night after the poisoning he became delirious, and developed hallucinations of sight, which lasted but a couple of days. The tongue was blistered and swollen; the lips, eyes, and rest of the face were œdematous. He had severe headaches, which were not relieved by ice applications. On the seventh night he entered into a condition of collapse, but rallied the next morning. On the ninth day the pain in the stomach ceased, and the patient could tolerate a little food. On the eleventh day he was able to leave his bed and walk about. He had lost twenty pounds during his confinement. Nine days after leaving bed (end of third week after taking the poison) severe, continuous, burning pains manifested themselves in the legs, preventing sleep. Three days later the pains appeared in the feet, which became swollen. The pains remained in the feet for nine weeks. He had never had pain in the arms, but some tingling in the hands. Two months after the accident he entered the hospital for treatment, where he remained eleven days. He was able to walk to the hospital, but when he left he had to be taken home in a coach. This inability to walk caused him to resort to crutches, which he was using when seen on October 15, 1894. He had never seen double, the facial muscles had never been affected, nor had there been any disturbance of the speech. An examination showed the following condition: "His gait is that of an ataxic; the legs are lifted high, to enable the toes to clear the ground, and are brought down with a stamp. The feet droop; they are cyanosed and cold; there is marked tenderness to pressure of the feet, legs, and thighs; involuntary contractions and twitchings are seen in the calf muscles. The muscles of the

tion of the rectum is found. When death has occurred within a few hours, the heart is usually found normal, otherwise there is commonly evidence of fatty degeneration, and there may be small hemorrhages into the endocardium and into the muscular tissues. Fatty degeneration of the liver is common, especially where life has persisted for more than a few hours. Congestion and fatty degeneration of the kidneys appear early. The mouth, throat, and œsophagus will present signs of irritation and inflammation if the poison be taken in a concentrated form.

Tests.—When the stomach is opened and its contents exposed, a careful watch should be kept for portions of arsenic in the solid state, which may be found present and unchanged. If such suspected material is found, it should be isolated with water and be allowed to settle. The heavy sediment should be examined under the microscope with reference to the detection of solid particles of arsenic if they be present.

When in solid form, arsenic is not soluble in water, but is soluble in a dilute solution of alkali. When heated, it is soluble in nitric or hydrochloric acid. If small particles of solid arsenic are placed in a reduction-tube and heated, the arsenic will be volatilized and deposited as octahedral crystals in the cooler portions of the tube. When arsenic is alone in solution, there are many tests which may be applied, and the results from each are fairly satisfactory. The best perhaps are the so-called ammoniocupric sulphate test and the ammonio-silver nitrate test. Both of these tests are very delicate, but neither of them is admissible in the presence of organic matter, and the first is interfered with by the presence of hydrochloric acid. When the solution to be tested contains, as it usually does, a variety of organic materials with the possibility of hydrochloric acid, the three most satisfactory tests are the sulphuretted hydrogen test, Reinsch's test, and Marsh's test.

Sulphuretted Hydrogen Test.—To the liquid in question a few drops of hydrochloric acid are added. It is then warmed and sulphuretted hydrogen is allowed to pass for several hours

tactile sensation in the hands and feet, but he was able to appreciate heat and cold. When he was examined with the battery as to the nature of the muscular affection, it was found that excitability to the electric current, whether interrupted or continuous, was very much diminished; the reaction was extremely sluggish, but did not present the reaction of degeneration. Otherwise he showed every sign of peripheral neuritis. He lost no control over his sphincters. He largely recovered on iodide of potassium, and is now able to walk very fairly, and his grasp is moderately good.

ARSENICAL COMPOUNDS COMMONLY USED AS POISONS.

Liquor Potassii Arsenitis (**Potassium Arsenite, Fowler's Solution**) is a transparent liquid having the color, taste, and smell of the Spirit of Lavender; a strong alkaline reaction, and contains 1 per cent. of arsenous acid in combination. This is the form in which arsenic is most commonly used in medicine, and for that reason accidental overdoses are not uncommon. A half-ounce, even in divided doses extending over several days, has been fatal, and in one case reported by Taylor death was not associated with vomiting and purging, but after death the characteristic appearances due to arsenical poisoning were present.

Copper Arsenite (Scheele's Green, Emerald Green) is a bright-green powder precipitated from copper solutions on the addition of potassium or sodium arsenite. It contains 1 part of arsenous acid to 2 of cupric oxide. It is used largely in the arts and in commerce, its most common use being as a pigment under the name of emerald green. It is also found in oil paint and water colors. It is insoluble in water, but is soluble in the acid fluids of the stomach. It has caused death accidentally when used as a coloring-matter for various food preparations, and several cases of poisoning have occurred among workmen using it. The tests are the ordinary ones for arsenic and copper.

Cupric Aceto-Arsenite (Schweinfurt Green, Brunswick Green, Paris Green, Vienna or Emerald Green).—This compound is a

immediately, the color of the hydrogen flame is changed to a bluish white, and there are fumes of arsenous acid. A cold porcelain plate is then placed close to the flame, and if arsenic be present, it will be deposited upon the plate in the form of dark-brown or black stains.

Illustrative Cases of Arsenic Poisoning.—CASE I.—Durell (*Transactions Massachusetts Medico-Legal Society*, 1888–98, ii. 37) reports a case of acute arsenical poisoning in a man aged twenty-four years, who was poisoned by arsenic administered in his food. August 4, 1886, he was struck on the back of the neck by an empty soap-box falling on him. He went home and told his mother of this injury; she prepared his dinner, which he ate; and almost immediately he complained of pain in his head, and began to vomit. The next day he was much worse; he had severe frontal headache and sighing respiration; face flushed, eyes injected; pulse 90; temperature 100° F. Heart action weak. August 6, the headache was less severe and the vomiting less frequent. There was a slight papular eruption over the surface of the body. August 7 and 8, vomiting constantly, excessive thirst, burning pain in the throat and stomach, and severe diarrhœa; headache had disappeared; face red and eyes injected. Mind was clear. The eruption increased. August 9, face flushed, eyes injected and jaundice; respiration sighing; temperature 100° F., pulse 104. Burning pain in the fauces and stomach, with great thirst; liver and spleen enlarged. There was some vomiting and the diarrhœa continued. The vomitus was examined, and crystals of white arsenic were found. August 10, patient better. Less diarrhœa and vomiting. Severe nose-bleed and great pain in the throat during the day. At 8.30 P. M. the pulse was 112 and weak. August 11, much worse. Liver and spleen more enlarged. Pulse 120, weak. There were many patches of ulceration in the mouth, inside of the lips, and the throat; throat very red; body jaundiced; eyes bloodshot and jaundiced. There was a papular eczema over the surface of the body and limbs. Abdomen was swollen. Mind was wandering at times, and the patient was very restless. At 5 P. M. pulse was 134; respiration 34; no

stance of very poisonous character. When inhaled even in small quantities it is apt to have very serious effects. Cases of accidental poisoning usually occur among workmen engaged in the process of separating silver from lead by means of zinc and hydrochloric acid, and in these instances it is due to the action of hydrogen on zinc containing an excess of arsenic.

June, 4-07.

ANTIMONY.

Antimony occurs in nature in various forms, pure, as an oxide, and a variety of sulphides. It is largely found in France and Germany and some of the British provinces. In commerce even the purest is not entirely free from foreign materials, chiefly iron, lead, and arsenic. It is a brilliant brittle material of a silver-white color when pure, or bluish white as it is commonly seen. It fuses at 430° C. and volatilizes at a bright-red heat, burning in the atmosphere.

There are but **two preparations of importance in toxicology,** these being **tartar emetic** and **antimonious chloride.** Tartar emetic or antimony and potassium tartrate occurs in small transparent crystals of rhombic form, becoming opaque and white on exposure to the air. After exposure for some time it changes into a white granular powder having a sweet and somewhat disagreeable metallic taste and a slightly acid reaction, soluble in 17 parts of water, insoluble in alcohol. When heated to redness, it chars and gives off an odor of burned sugar. It is the most common of the salts of antimony, is used in medicine, and not infrequently gives rise to cases of poisoning. For medicinal use it is frequently given in the form of antimonial wine, which is an officinal solution of tartar emetic in sherry wine, 2 grains to the fluidounce. To this preparation there is very little taste aside from that of the sherry, and it may be mistaken for the pure wine. Tartar emetic is a common ingredient in a certain class of proprietary cough medicines, so when they are taken to excess poisonous action may result. The commercial salt sometimes contains traces of arsenic.

Symptoms.—When tartar emetic is taken in poisonous doses,

the tubular portion. The ureters and bladder were normal. The large intestine was distended with gas, and contained a yellowish-green material, as well as some small semisolid portions of fecal matter. There were a few spots, especially in the lower portion, that were red, and the vessels were injected around these. The small intestine contained a quantity of yellow gelatinous material; the mucous membrane was red in spots. The mucous membrane of the duodenum was of a red color and the rugæ were almost black. The stomach was dilated to the capacity of a quart, and contained about a half pint of dirty greenish liquid. Its external coat was of a grayish color except in the dependent parts, where it was red. The mucous membrane was red in patches, and scattered over a greater part of it were a large number of small ecchymoses. The vessels were injected. The liver was of a striking yellow color, reddened in spots and greatly enlarged. The cut surface was of the same yellow color, and the acini could not be made out. The gall-bladder was filled with a reddish watery bile; its duct was free. Pancreas was normal. Brain and ganglia normal. On chemical examination large amounts of arsenic were found in all the viscera.

CASE II.—Meirowitz (*Journal of Nervous and Mental Disease*, N. Y., 1895, xxii. 178) reports a case of multiple neuritis following acute arsenical poisoning in a man aged nineteen years, who took a teaspoonful (about 70 grammes by weight) of white arsenic dissolved in water. Three hours after the ingestion of the arsenic severe pains came on in the stomach; he began to vomit, and continued to do so for three days at intervals of five to ten minutes; nausea was present between the attacks of vomiting; food could not be taken, and he developed an intense, burning thirst. Iron was prescribed as an antidote, but could not be retained in the stomach. The thirst was so intensely maddening that he attempted to leave the bed to relieve it, but he was so weak that he fainted. The pain in the stomach lasted for six days. The pulse was very weak. The urine was bloody and its passage caused considerable pain. The bowels at first loose, remained costive for four days. On the second day after the

the thoroughness and rapidity with which the poison itself has been removed from the stomach, either by vomiting or washing. The tongue is usually covered with a thick white coat, and the stomach and intestines with a considerable amount of mucus. Congestion of the brain even to the extent of minute hemorrhages into the substance frequently occurs. The blood is usually thin and there may be effusions into the serous cavities. Congestion in other organs is common. Eruptions on the surface of the skin, which may be either pustular or simulating the eruption of scarlet fever, have been noted in several instances. In a number of cases it has been impossible, even when death occurred soon after the taking of the poison, to detect antimony in the contents of the stomach.

Tests.—In cases of suspected poisoning by antimony the possibility of its presence in the liver or kidneys, even when absent in the stomach contents, should be appreciated, and these organs should always be submitted for chemical analysis.

To solutions containing organic matter hydrochloric acid should be added to coagulate the organic material, and tartaric acid to render perfectly soluble the antimony which may have been precipitated in the solution. It is then boiled and filtered, and if necessary concentrated. If sulphuretted hydrogen be passed through this solution, the antimony sulphide may be precipitated, orange-red or brown in color, which is insoluble in ammonia, but soluble in hydrochloric acid, which forms the chloride of antimony and gives off sulphuretted hydrogen gas. If this solution be boiled until the liquid becomes clear and then is added to water, a white precipitate of antimony oxychloride is produced, this white precipitate being soluble in tartaric acid.

This test is probably entirely characteristic of antimony if it be pure. Antimony responds to Marsh's test much as arsenic does; the deposit on porcelain, however, is darker and less brilliant. When ammonium sulphide is added to the crystalline antimony on the mirror, it immediately dissolves, and when evaporated leaves an orange-red deposit.

leg are atrophied. The thigh muscles have preserved their gross strength. The weakness affects the parts below the knee-joint. The foot, patellar and cremasteric reflexes are absent. The abdominal, epigastric, and gluteal reflexes are present. Control over the bladder and intestine is normal. The patient is able slightly to extend the feet, but finds it impossible to flex them. In the upper extremities it is the hands that are mainly affected. Owing to marked atrophy of the interossei, the lumbricales, the muscles of the thenar and hypothenar eminences, the movements of the fingers are greatly impaired. Flexion and extension of the hands and forearms are good. The atrophied muscles show the reaction of degeneration. Sensation to touch in the hand is greatly diminished. The reflexes in the upper extremities are absent. The muscles of the trunk show no effects of the poison, nor are there any disturbances referable to the central nervous system. Under treatment, consisting in the application of electrical currents and the administration of strychnine sulphate, he has improved, being now (January 5, 1895) better able to use hands and feet than formerly."

Case III.—Hadley (*Clinical Journal*, London, 1896, viii. 372) reports a case of chronic arsenical poisoning in a man who worked in "sheep dip," a compound in which arsenic largely figures. He was first taken sick twelve months before the date of reporting his case, when he was affected with what was called blood-poisoning, and was treated in the Infirmary. He had an eczematous, almost an ulcerated condition of both arms, and was practically cured. One month after being discharged he first noticed loss of power in the legs and feet, and in a few days his hands and arms became similarly affected. Following the eczematous condition were all the symptoms of peripheral neuritis. He had no headache, no vomiting, his pupils were equal and active, and his fundi normal. He had numbness of arms and legs, feet and hands, and paresis to such an extent that he could not walk, nor grasp a person's hand. The knee-jerks were absent; there was no ankle-clonus or other exaggeration of reflex noticed. On examining the numbness it was found that he had lost

of any food or liquid into the stomach; it was also induced by pressure. Temperature ranged from 97° to 102° F.; her pulse was small, weak, and 120. Tongue was yellowish brown and dry; skin was dry except upon one occasion; countenance anxious; mind clear. By the fifth day she was rejecting all food and medicine, and the attempt was then made to feed per rectum. She could not retain the injections, and they also caused pain. The vomitus was green and bilious looking; and the motions watery, brown, and sometimes slimy. About the sixth day spasms of the muscles and rigidity were noticed. The spasms were ushered in by pain in the rectum: then the muscles of the abdomen became rigid; the rigidity then extended to the legs and to the upper extremities. Each attack lasted not more than a half minute. They occurred independently of the vomiting. On Oct. 21, the day before she died, it was thought that she would recover if the vomiting would cease.

Postmortem Examination (*eight days after death*).—Putrefactive odor very slight. Body thin but not emaciated. The skin was of a pale yellow-green hue. There were dark rings around the sunken eyes; light livid green postmortem discoloration of the clavicular fossæ, inguinal region, and back, and to a less extent around the umbilicus and eyes. Lips dry; eyeballs collapsed; nose pinched; gums pale. No ecchymoses of surface or conjunctivæ, nor on the scalp, which was pale and comparatively bloodless. Brain: membranes pale and thin; no opacities; no hemorrhages; no ecchymosis. Ventricles dry and empty, with the exception of a small quantity of clear serous fluid in the fourth ventricle. Tongue thickly coated and yellow; the follicles at the back swollen. Air-passages free from obstruction; no hemorrhages. Lungs dry, crepitant, free from cavities, deposits, or hemorrhages; pleura free from petechiæ. Heart flabby and its walls thin but tough. Right and left ventricles covered with a considerable quantity of fat, which at the apex of the right ventricle invaded the muscle to the extent of one-third of its thickness. A little half-clotted blood in the right cavities; left empty. Valves thin with no deposits. One small puncti-

mixture of cupric acetate and arsenite, and appears as a green crystalline powder, insoluble in water, partially soluble in the acid fluids of the stomach. Like Scheele's green, it is commonly used in the arts as a pigment, but much less so of late years than formerly, and it is very frequently found in commerce. On account of its prevalent use as a poison, especially for potato-bugs, etc., it is not uncommonly used for suicidal purposes, and has been for homicidal. Local and chronic poisonings by those working with it are not rare, the symptoms presented being usually those of arsenic poisoning, and the treatment is the same. The tests are the regular tests for arsenic and copper.

Arsenic acid is a white non-crystalline deliquescent solid, very soluble in water, to which it gives a highly acid reaction. It is a purely artificial product, highly poisonous, but usually confined to the chemical laboratory, and therefore not commonly used for homicidal or suicidal purposes. The tests are similar to those for arsenous acid.

Alkaline Arsenates.—Sodium arsenate has been used in the preparation of certain fly-poisons and insect poisons, and as such has given rise to a few cases of accidental poisoning. The symptoms, treatment, and prognosis are similar to those from the arsenous acid.

Arsenic Sulphides.—There are two forms of arsenical sulphide occurring in nature, the red and the yellow. The red arsenous disulphide or realgar contains about 70 per cent. of the mineral, while the yellow arsenous sulphide or orpiment contains 71 per cent. The latter is much more commonly used in the arts than is the red, and is therefore more often a toxic agent. The symptoms and appearances produced are similar to those from arsenous acid, with which it is usually mixed. Fatal cases are rare, but have been reported.

Arsenic Chloride.—Arsenic chloride is a solution of arsenic in dilute hydrochloric acid and is used somewhat in pharmacy. It contains 1 per cent. of arsenous acid, and is therefore highly poisonous, and the strength being practically that of Fowler's solution, the results and tastes are much the same.

Hydrogen Arsenide.—Hydrogen arsenide is a gaseous sub-

grains of tartarized antimony per day, for three weeks in succession, with the exception of a few days that he omitted the medicine. When seen at the end of the three weeks he was so emaciated that his friends did not recognize him. Eyes sunken, conjunctivæ blanched; tongue coated with a brown fur, edge and tip very red and deeply fissured on its median line, and perfectly dry. Pulse 120, and rather hard; skin dry and shrivelled and of a deep-yellow color. Complains of great pain on pressure being made on the abdomen, which is more acute in the right iliac and epigastric regions. Anything taken into the stomach was immediately rejected. The nervous system was not in the least impaired. Lungs and heart normal. He had several dark and very offensive discharges from his bowels. He was first seen on Jan. 12, and in spite of all treatment he gradually failed and died on Jan. 24, retaining to the last his mental faculties.

Postmortem Examination (*fifteen hours after death*).—Emaciation very great. Intestines were considerably congested and inflamed; right iliac region very much so. Omentum inflamed, congested, and vessels enlarged. Stomach was of a dark appearance and inflamed on the surface. Spleen, liver, lungs, and heart normal. Gall-bladder was filled with darkish bile. Bladder normal and distended. On opening the stomach the whole surface was found to be inflamed. The mucous membrane was considerably thickened, softened, and disorganized in places, especially in the large curvature. Pylorus highly inflamed, with suppuration of its follicles. The intestines contained a small quantity of blackish thin matter, and a papular eruption was found throughout their whole extent. Some of the pustules were well formed and defined, but the greater number were in a state of ulceration. The duodenum, jejunum, and ileum were found inflamed, their mucous coats like that of the stomach, and their surfaces were copiously studded with the eruption. A section six inches in length of the jejunum furnished six large patches of these agglomerated pustules in a state of ulceration; they were generally covered over with a soft scab, and the muscular coat was not deeply involved. The

there is an unpleasant metallic taste in the mouth, burning pain and constriction in the throat, violent pain in the stomach followed by incessant vomiting, purging, extreme thirst, faintness, and all the symptoms of great depression. Mucus and blood may be present in the discharges. The pulse is rapid and feeble, the extremities cold and covered with perspiration; the respiration is painful, superficial, and rapid, followed by giddiness, great prostration, and insensibility. There is not infrequently tetanic or clonic spasm of the muscles of the extremities. Death may occur in stupor, convulsions, or delirium. In **chronic poisoning** the most prominent symptoms are nausea, vomiting, diarrhœa, emaciation, feeble and difficult respiration, with a metallic taste in the mouth, a slimy tongue, and an increase in the secretions, especially of the perspiration and urine. There is not uncommonly an eruption scattered over the body which is apt to be pustular in character.

In the chronic form ulceration of the tongue and mouth may occur. Taken together, the most prominent symptoms presented in poisoning by this drug are due to its irritating action upon the gastro-intestinal tract combined with extreme cardiac depression.

Dose.—The dose required to cause death is not large. Violent symptoms have resulted from ½ grain, and death in adults has followed 2 or 3 grains. Where a large dose is taken, the violent vomiting which rapidly ensues may be sufficient to clear out the stomach and save life. According to Taylor, 10 to 20 grains may be considered as the ordinary fatal dose.

Treatment.—Tannic acid is a fairly efficient chemical antidote. The stomach should be washed out and the symptoms of irritation, pain, and depression treated symptomatically.

Postmortem Appearances.—The postmortem appearances will vary to a great extent in different individuals. There are usually more or less inflammation and irritation of the upper gastro-intestinal tract, and a few cases have been reported in which this condition was absent, but in the majority there is a considerable amount of redness and swelling of the mucous membrane. The degree will apparently depend on

Postmortem Examination.—"The lips and mouth were black and excoriated, as was also the œsophagus; the stomach was uniformly covered with the chloride of antimony, of which about two ounces were collected. On removing this, the lining membrane of the stomach was seen black and charred, the submucous tissue being of a reddish hue; the small intestine, to the extent of about two feet from the pylorus, was of a dark color, and the lining membrane was easily detached. Nothing abnormal was observed in the appearance of the other thoracic and abdominal viscera."

MERCURY (HYDRARGYRUM, QUICKSILVER).

Mercury is **found in nature**, both pure and as an amalgam with silver, or in the form of chloride or native calomel, but most abundantly as the sulphide or native cinnabar. It is found widely distributed but in isolated localities, most largely in Spain, Italy, Caucasia, Philippine Islands, China, Peru, Mexico, and the United States. The mercury of commerce is obtained very largely from the sulphide. It is a shining silver-white metal, liquid at a temperature above 40° C., odorless, tasteless, and insoluble in the ordinary solvents, but soluble in nitric acid. It has a specific gravity of 13.5. It volatilizes slowly at the ordinary temperatures.

Mercury is frequently contaminated by foreign metals, especially lead, tin, zinc, and bismuth. Mercury in its pure form and uncombined state is almost inert when introduced into the animal economy. Very considerable amounts of it may be swallowed in its pure form without giving rise to serious symptoms. On account of its lack of solubility and its inert qualities it is not in this form used in medicine to any extent. When in combination it is largely used on account of various stimulating and alterative properties which it has. In the combined form its poisonous results are of common occurrence and are well known.

Chronic mercurial poisoning among those who are working with it is not at all uncommon. Those who are most commonly affected are the so-called water-gilders, looking-glass

When arsenic is treated in the same manner, a yellow deposit is left. Arsenic under similar conditions is dissolved by sodium hypochlorate, which has little effect upon antimony. If nitric acid is added to a suspicious mirror, it will be dissolved, but on evaporation the residue of arsenic gives to the silver nitrate a brick-red color, while the residue from antimony is not affected.

Illustrative Cases of Antimonial Poisoning.—CASE I.—Stevenson (*British Medical Journal*, London, 1903, i. 872) reports a case of poisoning by tartar emetic, administered in repeated doses. On July 28, the patient was admitted to the hospital, complaining of severe abdominal pain and fever. She stated that three weeks earlier she had been seized with pain in the lower part of the abdomen, coming on in attacks, generally worse at night. On admission the pulse was 108, respiration 28, temperature 99.4° F. She complained of severe pain across the lower part of the abdomen with fulness there, and it was so extremely tender that she could not bear examination. The swelling and tenderness were rather more marked above the right groin, and the pain extended up to the right loin. During the next fortnight the temperature varied from 99° F. in the morning to 103° and 104° F. in the evening. The pulse during this period ranged from 90 to 110, and the respirations from 22 to 28. The pain was often so severe that she required opiates. A little blood-stained mucus was noticed in the motions on one or two instances. On Aug. 11 the evening temperature reached 104.2° F., and the bowels were moved several times in consequence of some medicine. The next day it fell to 99° F., and from that time continued below 100° F. and gradually reached the normal. On Aug. 18 there was no tenderness on abdominal palpation, and on Aug. 20 she left the hospital quite convalescent and free from pain.

Fatal Illness.—Dr. Stevenson was called to see her on Oct. 10, and found her in bed suffering from diarrhœa, vomiting, thirst, pain and tenderness over the whole abdomen, and particularly at the epigastrium; vomiting was a prominent symptom, and was immediately produced by the introduction

SALTS OF MERCURY.

Mercury is official in a very considerable number of forms. All of the salts of mercury and mercurial combinations are more or less poisonous.

The symptoms presented in poisoning from the various combinations of mercury are very similar, and the postmortem appearances, treatment, and tests are very much alike. From a toxicological point of view by far the most important is corrosive sublimate, but we should also consider the so-called white precipitate and red precipitate.

CORROSIVE SUBLIMATE.

Corrosive sublimate (Hydrargyri Chloridum Corrosivum, Mercuric Chloride, $HgCl_2$) occurs as heavy colorless rhombic crystals or crystalline masses, permanent in the air, odorless, with a metallic taste and an acid reaction, soluble in 16 parts of water and 3 of alcohol. Corrosive sublimate is commonly used in medicine. *It is less apt to salivate than other mercurials.* It is most commonly used as an antiseptic and in the treatment of syphilis. It is also used in many cutaneous and chronic affections. In concentrated solution it acts as a strong corrosive poison.

Symptoms.—The symptoms may be acute or chronic. When acute, they usually come on immediately after taking the poison. The most characteristic are a strong metallic taste, with heat, burning, and choking sensations in the throat; severe burning pain is felt in the mouth, œsophagus, and stomach. Nausea and vomiting are persistent and the vomitus may contain blood. The abdomen is swollen and tender, and persistent purging associated with tenesmus is common. The discharges may contain blood. The pulse is rapid, weak, and irregular. The tongue is white and shrivelled, skin cold and moist, respiration painful and shallow. Intense thirst is always a prominent symptom. Urine may be suppressed or scanty. Muscular cramps in the extremities are common. If life be prolonged for two or three days, the ordinary symptoms of salivation and ptyalism will appear.

form hemorrhage on the mitral valve. This was the only petechia found in the body. Stomach contained about one and a half fluidounces of yellow turbid fluid, containing much bile and mucus. Its color externally was bright pink; the bloodvessels were injected; and its mucous coat was also injected. Mesenteric glands somewhat swollen. Intestines: the small intestine throughout had the bloodvessels at its mesenteric attachment rather red and prominent. Internally the mucous membrane was swollen, and the folds, especially at the tops, were prominent and injected. The condition was that of acute catarrh and streaky congestion, and the membrane was covered with bile-stained, somewhat glairy mucus. The ileum and colon were dilated, and the solitary follicles swollen and hard. No ulceration of the mucous membrane in either large or small intestine. Rectum hyperæmic. The contents of the bowels were semiliquid. No fecal odor anywhere. The liver was of a pale yellowish hue, dry, soft, and slightly fatty in patches. The gall-bladder contained one ounce of dark bile. Pancreas, spleen, and kidneys normal. Bladder just bathed with turbid urine; slight catarrh of the mucous membrane. Spinal cord very soft; no hemorrhages; normal to the naked eye. There was a marked absence of putrefactive odor about the body considering the time (eight days) that had elapsed between death and the postmortem. The general result of the necropsy may be thus summarized: the body of an anæmic young woman with no serious organic disease; the tissues dry and drained of fluid; acute gastritis; subacute enteritis; appearances suggestive of an irritant poison.

Chemical Analysis showed the presence of antimony in the stomach and bowel contents; in the liver, kidneys, and brain. Some in the intestine still soluble, probably as tartarated antimony. Calculated as this salt, the total amount found in the organs analyzed was 20.12 grains; 16.64 of which were found in the intestinal contents.

CASE II.—Le Boutillier (*North-West Medical and Surgical Journal*, Chicago, 1855, xii. 352) reports a case of chronic poisoning in a man aged thirty-four, who took from 20 to 30

sufficiently prolonged, salivation or the processes underlying it or associated with it may be apparent, and while this condition is frequently absent in the acute forms of poisoning, it is probably always present in the chronic forms. It must, however, be remembered that there are many other causes of salivation, and that while its presence is suggestive, it is far from conclusive. Salivation rarely comes on before two days after the taking of mercury, but Wood has reported a case in which it followed within a few hours the taking of a teaspoonful of corrosive sublimate.

Tests.—When the material is suspected to be corrosive sublimate in a solid pure state, or at least not mixed with organic matter, if a fragment be heated on platinum foil it melts and is volatilized in a white vapor without residue. When a portion is heated in a closed tube, it melts before subliming, and leaves a sublimate consisting of stellate prismatic crystals. The color is changed by the following reagents, potassium iodide giving a bright scarlet, potassium hydrate a yellow, and ammonium sulphide a black.

If the suspected material is in solution unmixed with organic matter, the following tests may be used, they being mentioned in the order of their delicacy. Potassium ferrocyanide gives a white precipitate slowly becoming yellow, and finally a light blue. Lime-water gives a yellow precipitate, potassium carbonate a brick-red precipitate. Potassium iodide gives a very characteristic pale-scarlet precipitate, which may appear yellow at first if the corrosive sublimate is present in very small amounts. Ammonia gives a white flocculent precipitate known as "white precipitate." Sulphurretted hydrogen and ammonium sulphide each give a black precipitate. Stannous chloride is followed by a grayish-black precipitate.

All these tests are quite accurate, and those mentioned first very delicate. Upon the combined results, if positive, satisfactory decision may be based.

cæcum was black and softened, very much like the stomach. The large intestine was more or less highly inflamed, and with eruption the same as in the small intestine. The left kidney was healthy; but the cortical portion of the right one, with adjoining mesenteric glands and two or three inches of ascending colon, were in a state of suppuration.

ANTIMONY CHLORIDE.

Antimony Chloride (Butter of Antimony) is much less common than tartar emetic, but is used in veterinary medicine and for browning gun-barrels. It has caused death in several instances, both accidental and homicidal. It is a violent corrosive poison. The symptoms and postmortem appearances simulate very closely those produced by the corrosive acids.

Treatment.—As in the case of tartar emetic, tannic acid or infusion of tannin, by precipitating the antimony in an insoluble form, acts as a chemical antidote. Otherwise the treatment is that for corrosive poisons.

Tests.—When antimony chloride is thrown into water, the oxychloride is formed and precipitated as a copious white flaky mass. This is soluble in tartaric acid, the solution being colored orange red by a drop of ammonium sulphide or a solution of sulphuretted hydrogen.

Illustrative Case of Antimony Chloride Poisoning.—Crisp (*Transactions Pathological Society*, London, 1865, xvi.) reports a case of poisoning by butter of antimony (chloride of antimony), in a girl aged nineteen years, who swallowed 3 ounces of the poison. It was taken at one o'clock in the afternoon, and the patient died about the same time on the following day (twenty-four hours). The prominent symptoms were severe pain in the region of the stomach, great anxiety of countenance, excessive thirst and vomiting, commencing about six hours after the poison was taken, and diarrhœa coming on a few hours before death. Little or no urine was passed and the mind was clear. A short time before death there was subsultus tendinum.

RED PRECIPITATE (MERCURIC OXIDE, RED OXIDE OF MERCURY, HgO).

Red precipitate occurs as heavy orange-red crystalline scales or powder, becoming more yellow the finer it is divided, permanent in the air, odorless, tasteless, very slightly soluble in water, not in alcohol, slightly soluble in nitric or hydrochloric acid. This substance is poisonous in much the same way, but not to the same degree as the white precipitate. Several cases of poisoning, both accidental and homicidal, have been reported. It may be readily recognized by its reaction to the ordinary tests for mercury and its red color. It may be, on account of its weight and insolubility, easily separated from ordinary fluids.

Illustrative Cases of Mercury Poisoning.—CASE I.—Taylor (*Guy's Hospital Reports*, 1864, x. 173) reports a case of chronic poisoning by mercury through the skin and lungs, resulting in death in four years. A male, aged thirty-two years, a furrier. "Four years ago he first began his occupation, which is to pack up the skins of animals that have been washed with an acid solution of mercury and afterward dried. For the first three years he did not suffer much inconvenience from his occupation beyond feeling some general weakness. About twelve months ago he found he could not hold his hand steady enough to shave himself, and he soon after lost complete control over his limbs. By degrees he lost voluntary control over his muscles when standing or moving about, and he began to have slight twitchings when in bed. He said he was salivated for about three months soon after he began this occupation; but that his gums had not been tender nor had he had any metallic taste about his mouth. He gave up work a month ago, and was admitted to the hospital." On admission he could walk tolerably well with a little assistance; but when standing could not control his limbs, which trembled considerably. He felt very much exhausted, had no sleep for several nights, and complained of headache. Tongue was furred, bowels costive, skin perspired profusely. He had

silverers, and quicksilver miners. Not only do they show the ordinary effect of mercurial poisoning, as salivation, but they are also not infrequently affected with "shaking palsy," vertigo, and other cerebral disorders. It is probable that these workmen are not affected by the handling of the metal itself, but by inhalation of the fumes rising from it, as it volatilizes at ordinary temperatures.

Symptoms.—There are certain symptoms which are typical of mercurial poisoning no matter in what form or combination the mineral is used. The early symptoms of ptyalism are usually a metallic taste in the mouth and slight soreness of the gums shortly followed by swelling of the gums with a whitish line developing along their edges. There is a peculiar disagreeable odor to the breath and salivation begins. If the poisoning continues, the gums, tongue, throat, and face become swollen. Ulcerations may appear upon the mucous membrane, salivation is extreme, and the swelling increases and is associated with an almost gangrenous condition of the mucous membrane. The teeth are loosened. There is sometimes a peculiar eruption of the skin.

Tests.—There are two tests which are very accurate and which may be applied to any of the salts or combinations of mercury. First, **Smithson's process**, which consists in the immersion in the suspected fluid of a tin plate lined with gold in the form of a spiral. This galvanic combination causes the precipitation of the mercury on the gold as a white stain. This stain is then volatilized in a small tube and a characteristic globule is obtained if it be mercury. Second, if a minute portion of any of the preparations of mercury, either in solid state or in concentrated solution, be placed upon a bright plate of copper and a drop of a strong solution of potassium iodide added, a silvery characteristic stain will immediately appear on the copper.

natural and reactive to variations of light; they were subsequently contracted; respiration normal at first; pulse about 100, small and feeble; feet and hands cold; violent vomiting and purging, the former occurring at first every two or three minutes, subsequently every half-hour. The vomited matter consisted of mucus and albumin (the later had been administered) tinged with blood. Purging every hour throughout the day; the stools consisting at first of little else than mucus and blood, became more and more feculent. The tongue was covered with a grayish-white crust, resembling the effect of nitrate of silver; its margin was of a bluish color. There were great heat and soreness of the mouth, fauces, and œsophagus, especially while in the act of swallowing any liquid; the gums had receded from the base of the crowns of the teeth and presented a leaden-blue margin; there was some pain at the scrobiculus cordis; the abdomen was, however, generally free from pain; there were occasional cramps of the lower extremities. On the 18th, the symptoms were ameliorated; stools were more feculent; vomiting and purging had abated; the vomited matters were of a blackish-green color; pulse 90, soft and small; scarcely any sleep. On the 19th vomiting and purging at intervals of three-quarters of an hour; he became delirious. On the 20th the symptoms were aggravated; the blue line around the border of the gums was still observed; there were general tremors, with cramps of the extremities. He died at 9 P. M. on the 20th, having survived the effects of the poison rather more than four days.

Postmortem Examination (*sixteen hours after death*).—Membrane of the brain rather opaque; a quantity of fluid beneath the arachnoid. The whole brain was remarkably pale; two apoplectic cysts were found. Lungs appeared somewhat consolidated, as if from early pneumonia, their tissue readily breaking down on pressure. Heart healthy; its cavities filled with colorless firm fibrin. Kidney: secreting structure congested; mucous membrane of one pelvis had a spot of ecchymosis. Bladder empty and contracted; some small pink spots on its mucous membrane. Œsophagus: the mucous membrane had a vermilion hue. Stomach presented a pink

The chronic form of poisoning by corrosive sublimate does not differ from that already described under mercury. The external application of corrosive sublimate when in concentrated solution has caused death, presenting similar appearances to that following its taking into the mouth.

Dose.—People vary much in their susceptibility to mercurial poisoning. So far as is known, the smallest fatal dose reported in adults is about 3 grains, but recovery has taken place after the administration of more than 60 grains. Taylor reports a case in which death occurred within a half-hour after the taking of an unknown quantity. This is believed to be the shortest period on record. In a large proportion of cases life persists for several days, from one to ten.

Treatment.—The best antidote for acute mercurial poisoning is albumin, with which mercury combines in the form of an insoluble albuminate of mercury. This is best given in the form of eggs. It is, however, a fact that a large excess of albumin will redissolve the otherwise insoluble salt. The white of one egg is said to be capable of neutralizing 4 grains of corrosive sublimate. If eggs are not available, milk or a paste made of wheat flour is probably next best. The stomach should be emptied and the symptoms treated as they arise.

Postmortem Appearances.—Aside from the conditions described under chronic mercurial poisoning and the swollen, inflamed condition of the mouth, tongue, and œsophagus due to the corrosive action of the poison, the most characteristic appearances are found in the stomach and intestines. The corrosive action of the poison upon the walls of the stomach and intestines is well marked, and similar to that from arsenic. The mucous membrane of the stomach is more or less inflamed, either diffusely or in patches, and under the patches of inflammation extravasated blood may be found. Similar appearances will be found in portions of the intestinal tract, more commonly and more prominently in the cæcum. Perforation of the stomach is rare, but has occurred. The kidneys and bladder are usually inflamed, in the kidneys more especially about the Malpighian bodies. In cases in which life has been

few days before her death she complained of pain in the rectum, and on examination, a prolapsus ani was found, and it was noticed that the protruded intestine was of a very dark color. During the last month albumin appeared in the urine; the legs became œdematous; the breathing, which had been short for some time, became more panting and frequent; the heart's action became weak; and the patient sank and died in the beginning of April, 1867."

Postmortem Examination.—Lower extremities were œdematous. Left lung was contracted and adherent on all sides in the pleural cavity, which was diminished to two-thirds of its natural size. Heart showed extensive pathologic lesions. Hypertrophy, valvular disease, and fatty degeneration of the muscular tissue. Dilatation of aorta. Stomach had thin walls, and its mucous membrane near the pylorus showed a few spots of ecchymosis. In the duodenum there were extensive patches of ecchymosis and Lieberkühn's follicles were enlarged. The jejunum and ileum were pale but tolerably healthy. The internal surface of the large intestine was remarkably black, mottled in parts with patches of a lighter hue, the color commencing at the ileocæcal valve, and contrasting strongly with the light color of the small intestine. The mucous membrane was smooth and shining, and there was no ulceration or abrasion of the surface, but the whole presented the appearance of the skin of a toad's back. On microscopic examination of sections of the intestine the coloring-matter was found to be deposited in the submucous tissue between the epithelial and muscular coats, and to consist of: first, large black opaque masses of irregular form; and second, minute granules, sometimes separate, and sometimes grouped together. About four inches of the cæcum were analyzed, and well-marked globules of metallic mercury were found. Liver was diminished to about a third of its natural size, and was of a reddish-buff color. Its whole surface presented a granular appearance from the presence of light buff nodules. On microscopic examination the fibrous tissue appeared much hypertrophied; and the hepatic cells were shrivelled and irregular in shape and contained a large number of granules.

CALOMEL (MERCUROUS CHLORIDE, Hg_2Cl_2).

Calomel is used in medicine very largely, and on account of its common use, with which almost all people are familiar, it is not generally considered as a poison, and yet it may produce death when given in doses which would not be considered excessive, providing there is an idiosyncrasy on the part of the individual. In such cases death is apparently the result of excessive salivation and ulceration, with the exhaustion and toxæmia dependent on them. Cases are not infrequent in which subacute poisoning follows the external use of black wash, which consists of 1 drachm of calomel to 8 ounces of lime-water. In large doses calomel acts as does corrosive sublimate, but in a milder way, as an irritant poison. When poisoning from calomel occurs, the possibility of contamination with corrosive sublimate must be considered. In the form in which it is commonly sold in the shops it occurs as a white impalpable powder, permanent in the air, odorless, nearly tasteless and insoluble in water, alcohol, or ether. When heated in a glass tube or on platinum foil, it volatilizes or sublimes without melting. It is blackened by ammonia, while corrosive sublimate is not affected.

WHITE PRECIPITATE (AMMONIATED MERCURY, NH_2HgCl).

White precipitate is obtained by precipitating a solution of corrosive sublimate with ammonia. It is used in medicine to a certain extent, as in ointments, and also in the arts. It occurs as a white powder, permanent in the air, odorless, tasteless, and insoluble in water or alcohol. It is soluble in a cold solution of sodium hyposulphite with the evolution of ammonia. On being heated, a red mercuric sulphide separates, and on boiling it turns black. It has in several instances been swallowed, when it acts as a violent irritant, the symptoms being the same as those associated with the stronger salts of mercury.

Lead salts give rise to various forms of poisoning, acute, subacute, and chronic. Chronic forms of lead poisoning occur usually among workers in lead, and apparently from the inhalation of its fumes; in painters handling and exposed to the fumes of white lead, and in those who obtain it through drinking-water, cooking utensils, etc., in the form of bicarbonate. Acute cases of poisoning are rare, but a number have occurred from the taking of some of the soluble salts. The most common sources of acute poisoning are lead acetate, lead chromate, and red lead. The two latter forms are comparatively rare, but cases have been reported of each.

LEAD ACETATE.

Lead Acetate (Plumbi Acetas—Sugar of Lead—$Pb(C_2H_3O_2)_2.3H_2O$) is commonly used in medicine externally, usually in the form of liquor plumbi subacetatis dilutus as an external application, and it is also used internally. It is used in the arts of dyeing and calico-printing, and is commonly found in hair-dyes.

When pure, it occurs as colorless, slimy, transparent, prismatic crystals efflorescent and combining with carbon dioxide on exposure to the air.

Its properties are a slight odor and sweetish, astringent taste and a slightly acid reaction. It is soluble in water, less so in alcohol.

Action.—In ordinary medicinal doses it is a powerful astringent and sedative. Externally it is used as an evaporating lotion, as a liniment, and as an astringent. When taken in poisonous doses it is an irritant poison.

Symptoms.—It is not a very active poison, but when from 1 to 2 ounces have been taken the symptoms which follow are largely those associated with the taking of any irritant poison: burning pain in the mouth and throat, dryness and thirst, vomiting, and severe epigastric pain, the vomitus containing a white curdy material (lead chloride); there is diarrhœa or constipation, with black stools (lead sulphide). When death is not rapid, the symptoms of various forms of

continuous spasmodic movements of the muscles of the chest. Urine high-colored. Admitted to hospital on the tenth. Eleventh: his limbs had constant spasmodic movements very much resembling those of chorea. Twelfth: felt sore all over his limbs; where they came into contact with the bed they looked quite red and inflamed; delirious. Fourteenth: continued delirious; spasms continuing very violent; pupils contracted. Seventeenth: slight spasms only; passed his urine involuntarily. Eighteenth: was quite quiet if not disturbed; could not protrude his tongue very well; spasms disappeared; still passed his urine involuntarily. Nineteenth: pulse 126; quite still; it took some time to make him understand what was said to him, although he answered when spoken to; bowels not relieved. Twenty-fourth: he grew weaker and would scarcely take any food; has had no return of spasm. He fell into a state of unconsciousness, and death took place on the 25th, fifteen days after his admission."

Postmortem Examination.—Body well nourished, not at all wasted, and the muscles of a normal red color. The brain and spinal cord were carefully examined and appeared to be healthy. The lungs, heart, liver, spleen, and kidneys presented no morbid appearance.

Upon **chemical analysis** mercury was found present in the substance of the kidneys, liver, and brain.

CASE II.—Taylor (*Guy's Hospital Reports*, 1846, iv. 468) reports a case of **acute poisoning by corrosive sublimate** in a man who swallowed a quantity of poison with suicidal intent on the morning of April 16, about eleven o'clock. He was shortly after taken with violent vomiting and purging; he experienced great heat and soreness of the fauces and œsophagus in the act of swallowing the poison. The man was admitted to the hospital at half-past eleven. He had the following symptoms on admission: Cold extremities; general lividity of the surface, especially about the backs of the hands, cheeks, and forehead, which presented a purplish-black appearance. He appeared anxious and despondent, and was affected with rigors and frequent chattering of the teeth, without any sense of cold in any part of the body; pupils at first were

colic in which the pain may be severe and is usually located about the umbilicus. Loss of strength, loss of flesh, cold, moist skin, and a rather dull, listless expression are usually associated with it. Perhaps the most definite appearance on physical examination, and the one upon which a diagnosis may be based with a great degree of certainty, is the presence of the so-called "blue line," which appears along the line where the gums come into contact with the teeth. Its presence is most marked over the incisors, and is due to the deposition of lead sulphide in the capillaries of the gums. Silver and mercury may also produce a somewhat similar appearance, and it may be absent in lead poisoning, but when present to any considerable degree it is in itself almost diagnostic. In certain cases of lead poisoning the symptoms of digestive disturbances may be almost entirely wanting, while those which depend upon the effect of lead upon the nervous system may be very prominent. The most important of these are so-called "lead-palsy" or "lead paralysis," which is most commonly located in the muscles of the arms, resulting in the well known "wrist-drop." Epileptiform convulsions occur not infrequently among the later symptoms of chronic lead poisoning.

Postmortem Appearances.—The conditions found on postmortem examination in cases of acute lead poisoning are not distinctive. There may be no well-marked lesions, but as a rule, if the solution of lead be a concentrated one, inflammation of the digestive tract will be apparent. Occasionally the mucous membrane of the stomach and upper intestine will be covered with a grayish-white membrane composed of mucus. When lead is given in small doses, it is decomposed in the gastric juice and has no corrosive action. In chronic cases, aside from the points already considered under the symptoms, such as the "blue line," swelling, and ulceration of the gums and mucous membrane of the mouth, and wasting, there will probably be found nothing characteristic at the autopsy. The large intestine will probably be contracted, and muscles which are sufficiently affected will be flabby and whitish in color.

color on its inferior surface, near its middle; some fibrin upon it. Duodenum tolerably healthy. Small intestine healthy, lined with thick yellow mucus. Cæcum and ileocæcal valve showed signs of the most intense inflammation; some portions of a deep purplish-black color, with patches of sloughing mucous membrane tinged green by feces. Colon and rectum also exhibited traces of the most violent inflammation, especially the ascending and transverse colon. Here were found oval patches of sloughing mucous membrane about the size of small almonds, and tinged green by feces passing over them. These patches were symmetrically disposed throughout nearly the whole extent of the large intestine, in transverse rows of three, each patch corresponding to a sacculus, and separated from its neighbor by a longitudinal band of muscular fibre. The mucous membrane between these was of a deep purplish-black hue, with arborescent vessels at small intervals.

Case III.—Williams (*Transactions Pathological Society*, London, 1867, xviii. 111) reports a case of chronic poisoning by calomel. "A lady, aged seventy-four years, had for the last forty-three years of her life been in the habit of taking a grain of calomel every night, except on some twenty occasions, when she substituted either blue pill or gray powder. In addition she took an extra dose of calomel varying from half a grain to one grain twice a week. For many years her health was not materially impaired, and she enjoyed a good appetite and digestion. Ten years ago she was attacked with pleurisy of the left side, followed by partial collapse of the chest on that side, and two years later she had an attack of disease of the heart, the auscultatory signs last June being a systolic murmur at apex, midsternum, and under right clavicle, and also a double second sound. Latterly the bowels were easily moved, half a teaspoonful of castor oil being sufficient to act on them, and the motions were dark and very offensive. She was also troubled during the last year and a half with flatulence and fugitive pains in the right and left iliac regions, but she never had any tenderness. These symptoms were always relieved on the bowels being moved by the habitual doses of calomel. A

tions a case of **acute poisoning by acetate of lead.** Man, aged sixty-nine years, transferred his property to his wife on March 24. A few days afterward he was taken sick and on March 31 a physician was called. He noted yellowness of the conjunctivæ, loss of appetite, eructations, mucous râles, weakness, and vertigo; dejections normal; no thirst; pulse 80 to 90; tongue coated. April 2 he was somewhat better; but in the evening there occurred vomiting, rapid dissolution, small pulse, cold extremities, gurgling respiration, followed by death. There were no pains, cramps, or retractions of the abdomen.

Postmortem Examination.—*Twenty days after burial* the body was exhumed, and was found to be undergoing dry decomposition; skin easily detached, abdomen green. Suggillations on back, breast, arms, and thighs. Eyes sunken. Mucous membrane of mouth pale. Brain pulpy and soft; lateral ventricles contained a small amount of fluid. Membranes opaque; bloodvessels and sinuses empty; lungs engorged; pericardium contained some bloody serum. Heart normal. Mucous membrane of the œsophagus was discolored and covered with mucus. Stomach intact; mucous membrane somewhat loose, but otherwise normal; no trace of inflammation, ecchymosis, or erosion. Stomach contained a greenish fluid with some food. Intestinal canal was of a dirty brownish-red color; mucous membrane normal; intestinal contents were a greenish-red fluid. Liver pale, firm, somewhat smaller than normal. Gall-bladder contained a little bile. Spleen friable. Kidneys normal. Bladder empty. The stomach and intestines and their contents were **examined chemically**, and were found to contain 0.870 gramme of metallic lead, equivalent to 1.60 of acetate of lead.

Case II.—Laslett and Warrington (*Brain*, London, 1898, xxi. 224) report a case of **chronic lead poisoning.** House painter, aged twenty-eight years. Admitted to hospital, January 14, 1898. He had been engaged in his occupation since his twelfth year and two years ago suffered from colic. Eighteen months ago noticed weakness and wasting of the hands, which attracted his attention before the

There were patches of fatty degeneration. On analysis for mercury, no trace of the metal could be found. The gall-bladder was enlarged and was filled with sienna-colored bile, and contained ten gall-stones. Spleen was shrunken, hard, and very dark in color. Right kidney was small, its capsule adherent, and the surface granular: on section the cortical portion appeared granular and greatly diminished, and the pyramids somewhat displaced. Left kidney was enlarged and congested, its capsule more or less adherent and the surface granular: on section the substance was dark in color, and the cortical portion diminished in extent.

QUESTIONS.

Describe poisoning by arsenic
By antimony.
By mercury.

CHAPTER V.

METALLIC IRRITANTS (Continued.)

LEAD.

LEAD occurs in nature widely diffused, most commonly as an oxide or sulphide, the latter being known as galena. It also occurs in saline combinations as native sulphate, phosphate, carbonate, chromate, molybdate, tungstate, and arsenate. The metal is recovered usually from galena, the richest deposits of which are found in the United States, especially in Wisconsin and Arkansas.

Properties.—Lead when pure has a soft bluish color, and is very malleable, presenting a bright surface when freshly cut. It has a perceptible taste. It is little changed by the action of air alone, but when the air is combined with rain-water a hydrate is formed, afterward changed into the carbonate, which when exposed to the action of the water becomes a bicarbonate which is soluble and poisonous.

Lead in its pure state is not used in medicine, but its salts are freely used, sometimes internally and largely externally.

seventh, and eighth segments were examined. Posterior roots appeared quite normal. Anterior roots in each segment showed distinct atrophy of nerve-fibres, which was more marked in the seventh root, but in none was the atrophy equal in extent to that found in the posterior interosseous and ulnar nerves. Muscles: The change in the extensors of the hand was extreme. Over 90 per cent. of the fibres were atrophied. They retained their cross-striation, and with the exception of a few fibres no evidence was found of an acute fatty change. The connective tissue was much increased: The interossei were very much less altered. Muscle spindles: They were quite unaltered and in every case the nerves in the spindles were normal. Spinal cord: In the fourth and fifth segments nearly all the cells showed the usual normal structure with a central nucleus and a definite distribution of the chromatic masses giving to the cells generally the well-known striated appearance. A few, however, showed changes similar to those found in the sixth and seventh segments, where many cells showed an obvious deviation from the normal; in these cells the nucleus was often found placed very eccentrically and also the Nissl bodies were dispersed over the body of the cell in the form of fine powder, and often in the central mass of a cell an actual disappearance of the blue coloring-matter was noticed, the result of a process of chromatolysis. The proportion of altered to normal cells was about 1 in 4; they were found equally on both sides and had no special distribution among the various cell groups.

Jan 9-07.

COPPER (CUPRUM).

Copper is a metal which is commonly and widely distributed in nature, usually in one of four forms, as pure copper, as an oxide, as a sulphide, or as one of its salts, the most common of which are the sulphate, carbonate, arsenate, and phosphate.

Properties.—When pure, it occurs as a lustrous metal of reddish color, very malleable and tenacious. It has a slightly nauseous taste, and gives off a disagreeable odor when

nervous disturbances are present. These may take the forms of cramps in the calves of the legs, pain over the nerves, paralysis, or giddiness and stupor. If life is sufficiently prolonged, the characteristic blue line will be noted about the margin of the gums where they join the teeth.

Dose.—The amount of acetate required to cause violent irritant poisoning and death is a rather large one. Accurate figures are wanting in this connection. It is probable that from 1 to 2 ounces will cause death in a vast majority of cases, but at least one case has been reported in which the amount taken could hardly have been more than ½ ounce. In the acute, fatal cases life usually persists for from two to four days.

CHRONIC LEAD POISONING.

Occurrence.—As has been suggested, chronic poisoning takes place in one of three ways:

First. Where it is taken internally, as in drinking-water.

Second. Where it has been applied to the surface of the skin as in pigments, hair-dye, or to open ulcers and wounds as a surgical dressing.

Third. Where it is inhaled, as among lead-workers, painters, artists, etc.

Lead is a cumulative poison, but accumulates slowly.

Onset.—The rapidity with which the symptoms come on varies with the susceptibility of the individual and rapidity with which the poison is taken. These conditions are so well known and recognized as to have been named after their most prominent symptoms. Chronic lead poisoning is usually known under the names of lead colic, painters' colic, and lead-palsy.

Symptoms.—As a rule the first symptoms presented in cases of chronic lead poisoning are debility, general malaise, attacks of indigestion, loss of appetite, constipation, thirst, and a metallic taste in the mouth. When the bowels do move, the stools are usually dark colored from the presence of lead sulphide. The urine is usually scanty and high colored. The breath is fetid. There are frequently attacks of

chronic poisoning are very similar to those of lead. Several cases have been reported in which the hair and skin had taken on a greenish color, and the blue line about the gums noted in lead poisoning is displaced by a green line in poisoning by copper.

Dose.—In medicine copper sulphate is given as an emetic, as a tonic, and it has been used for the purpose of procuring abortion. The medicinal dose is from 3 to 15 grains. Doses of this size have caused very considerable gastro-intestinal irritation. A half-ounce of the sulphate usually causes serious symptoms, and such doses are frequently given for the purpose of abortion. Percival reports a case in which the taking of 60 grains was followed by violent convulsions.

Treatment.—The best chemical antidote is potassium ferrocyanide, which when given freely forms with the poison a very insoluble copper ferrocyanide. Soap and the ordinary alkalies have a somewhat similar, but a weaker, effect. Milk and the white of eggs are indicated, as they form insoluble copper albuminates. In addition to the action of these antidotes, the stomach should be emptied by emetics or stomach-pump, and the symptoms treated as they arise.

Postmortem Appearances.—Where life has been sufficiently prolonged, the skin and hair may present some greenish discoloration from the copper, and jaundice is almost always present if death has been delayed for a few days. The condition of the digestive tract will depend largely upon the concentration of the poison. When sufficiently strong to cause rapid death, the mucous membrane of the mouth, œsophagus, stomach, and intestines will be found inflamed and swollen, and if the solution is a concentrated one, there may be spots of hemorrhage in the tissues. If the poison is taken in solid form, undissolved particles may be found on the mucous membrane of the œsophagus or stomach. In a very considerable number of cases there is congestion of the lungs. The kidneys are congested. The urine may be scanty and contain blood, and copper may be almost invariably found in it if it is examined within a few hours after taking the poison.

LEAD CHROMATE (CHROME YELLOW, LEMON YELLOW, PARIS YELLOW ($PbCrO_4$)).

Lead Chromate is commonly employed in the arts as a pigment and on account of the frequency of its use both in painting and as a coloring-matter in various edible preparations has not infrequently given rise to cases of poisoning. It has been used in confectionery, buns, etc., as a substitute for eggs, furnishing the yellow color which is ordinarily produced by them. Chrome yellow commonly contains a considerable amount of lead carbonate and lead hydroxide, which, on account of their solubility, naturally increase the poisonous effect.

The postmortem appearances, symptoms, and tests of chrome yellow do not materially differ from those of cases of poisoning by any other of the soluble lead salts.

Treatment.—In acute lead-poisoning the digestive canal should be cleared of poison by means of the stomach-tube and cathartics. A perfect chemical antidote is wanting, but dilute sulphuric acid, Epsom salts, Glauber's salts, or sodium and magnesium sulphates will be of service, as they combine with the lead, forming an insoluble sulphate, so rendering it innocuous.

Tests.—The detection of lead in pure solution or in solid form is not difficult. When it is mixed with organic substances in solution, the organic matter must be removed. This may be done by evaporating it to dryness and incinerating the residue. What remains is then dissolved in nitric acid, again evaporated to dryness over a water-bath, the residue dissolved in water, and the ordinary tests applied. When sulphuretted hydrogen is passed through an acid solution of any of the lead compounds, a black precipitate follows. The same occurs with ammonium sulphide. With potassium iodide or potassium chromate the precipitate is yellow. On the application of sulphuric acid a white precipitate is formed.

Illustrative Cases of Lead Poisoning.—CASE I.—Maschka (*Handb. d. gericht. Med.*, Tübing., 1882, ii. 281) men-

cyanotic, pulse small and increased in frequency. Vomitus was blue, and contained particles of the poison. He had several loose, greenish-yellow stools containing no blood. Urine scanty; no blood or albumin. During the night he was very restless; on the next day complained of very severe headache, pain in epigastrium, and burning in mouth and œsophagus. Vomiting ceased. Urine was scanty, and contained albumin, blood, and bile-pigment. Patient went home, but was brought back on October 15. He had marked icterus, pallor of the mucous membranes, diminished temperature, frequent pulse, great weakness, cardiac oppression, restlessness; stools were pappy, brownish-red, and streaked with blood; tenesmus and very bloody urine. Region of the stomach and liver sensitive; liver enlarged; abdomen retracted. Jaundice decreased somewhat up to the 18th. Then there were apathy, cold sweat, and collapse resulting in death.

Postmortem Examination (*two days after death*).—Skin was pale with a tinge of yellow. Rigor mortis in the lower extremities. There was not much blood in the sinuses, or in the brain or its membranes. The veins of the neck contained but a few drops of fluid blood. Mucous membrane of the trachea and œsophagus was pale. Left lung was pale and œdematous in the upper lobe; the lower lobe was swollen, hard and friable, and contained a quantity of foamy fluid. Right lung contained fluid of the same kind. Heart and great vessels contained almost no blood. Heart substance was pale, soft, and easily torn. Stomach and intestine distended; serous coat was of a slate-gray color. Spleen normal. Liver soft, easily torn, fatty, moderately full of blood, and of a yellowish-brown color. Gall-bladder contained a few drops of dark tenacious bile. Kidneys swollen, cortex yellowish, pyramids pale brown. Bladder contained some urine; otherwise normal. Stomach contained a quantity of brown feebly acid liquid. Mucous membrane was swollen, thickened, and covered with tenacious mucus; along the greater curvature it was greenish in color. In the fundus was an eschar as large as a one-cent piece, where the mucous membrane was brown,

wrist drop, which was the prominent feature on admission. Condition on admission: Patient a rather emaciated man with an anæmic, sallow complexion, and puffy eyelids. The body was covered with numerous small purpuric spots. There was a characteristic blue line on the margin of the gums. Heart showed signs of dilatation and hypertrophy. Urine sp. gr. 1012, some albumin and granular casts. Nervous system: Upper extremities. Marked general muscular wasting and dropping of the wrists were present on both sides to an equal extent. Muscles of the thumb were distinctly atrophied. Wasting, with complete loss of power, existed in the extensors of the wrist, fingers, and the thumb. No marked wasting in the flexors of the wrist and fingers. In the upper arm the triceps and supinator longus were markedly wasted, and the biceps to a much less extent. The deltoid and pectoral muscles were also greatly wasted. Lower extremities. The vasti interni and peronei were wasted, and much general weakness was present. The extensors of the wrist and fingers did not respond to either the faradic or constant current. The small muscles of the thumb gave the typical reaction of degeneration with the galvanic current. The knee-jerks were obtained with great difficulty. About one month after admission pulmonary complications set in, to which he succumbed in a few days.

Postmortem Examination (*forty-eight hours after death*).—Lungs were extremely congested and œdematous, and the heart markedly hypertrophied and dilated. Kidneys were typically granular and contracted. Brain was pale and œdematous. Peripheral nerves: sections of the posterior interosseous nerve showed marked atrophy of the nerve-fibres, quite half having disappeared. After treatment with osmic acid, five of the nerve-fibres showed breaking up of the myelin. The fibres which took the stain presented the normal black ring and did not show any indications of an acute change, with the exception of a few which appeared swollen. Ulnar nerve: Fibres not degenerated, but in cross-section considerable atrophy was found, but less marked than in the posterior interosseous nerve. Spinal roots of the sixth,

prisms or needles, slowly efflorescing in dry air, odorless, having a sharp saline taste and an acid reaction. It is used in medicine as an astringent, and in large doses as an emetic. It has been given in cases of dyspepsia and the night-sweats of consumption, in epilepsy and in other spasmodic diseases. As an astringent it is not uncommonly prescribed in the treatment of urethral inflammation, as a gargle for the throat, and to check hemorrhage from a bleeding surface.

Symptoms.—Zinc sulphate in large doses is an irritant poison, the symptoms being an astringent taste, abdominal pain, and excessive vomiting with purging. Symptoms come on almost immediately after the drug is taken. According to Taylor, "the sulphate appears to act as a pure irritant and has no corrosive properties. It may cause death indirectly as the result of exhaustion from violent vomiting, when an ordinary dose has been given to a person debilitated by disease. It does not appear to be a very energetic poison." In appearance it resembles Epsom salts, and has been very frequently taken by mistake for these salts.

Dose.—Death has occurred from the taking of 60 grains, while recovery has followed the taking of 1 to 2 ounces. In the latter cases, however, it is probable that the prompt emesis following the taking of the drug resulted in the removal from the stomach of a large part of the dose. Death usually occurs in from twelve to twenty-four hours after the taking of large doses.

Postmortem Appearances.—The conditions found on postmortem examination are those usually associated with poisoning by any of the irritants: reddening, softening, and swelling of the mucous membrane lining the digestive tract. Congestion of the brain and lungs and hemorrhage into the pleura have been noted. The heart is usually flabby.

Tests.—When to a watery solution of this salt potassium ferrocyanide, ammonium sulphide, or barium chloride is added, a white precipitate is formed.

Illustrative Case of Zinc Sulphate Poisoning.—Platner and Pignacca (*Gazz. med. ital. lomb.*, Milano, 1848, i. 110; *Brit. and For. Med.-Chir. Rev.*, London, 1849, iii. 545) report a case of

rubbed. Its specific gravity is 8.92, and its fusing-point 2538° F. On exposure to the air it undergoes tarnishing. With oxygen it forms two salts, cuprous oxide, Cu_2O, and cupric oxide, CuO; and cupric oxide forms with the various metals a number of alloys, the best known being its combination with zinc, which is called brass, and that with tin, which is called bronze.

Action.—Copper when pure is perfectly inert, has no effect upon the animal economy, but all its salts are poisonous, and when the pure copper is taken into the stomach, combinations will take place which may render it extremely poisonous.

Copper is commonly **used in the arts** in the form of metal and its salts are used as pigments. They have been largely used not only for coloring paper and sweetmeats, but also for fruit, pickles, peas, etc.

Accidental poisonings by copper are not at all rare among those who work in the metal, and death also has occurred from foods colored by it, and from foods cooked in copper vessels, especially if those vessels have not been kept clean. All the copper salts are poisonous, the most important being copper sulphate, or blue vitriol, and the subacetate, or verdigris. The arsenite or aceto-arsenite has been described under the head of arsenic. A copper carbonate which results from the action of moisture on brass or copper is also sometimes called verdigris. Poisoning by copper may be either **acute or chronic.**

When taken in large or concentrated doses, the **symptoms of acute poisoning** by any of the salts of copper are similar. There are metallic taste in the mouth, nausea, vomiting, and violent pain in the stomach and abdomen, headache, and in certain cases convulsions and spasms of the muscles of the extremities may occur. Diarrhœa is common, and the stools may be dark-colored or bloody. Jaundice has been noted in a number of cases. A rapid, irregular pulse, great thirst, diminished amount of urine, and great prostration are the common symptoms. The material vomited is usually whitish or greenish, being stained by the copper. The **symptoms of**

phosphorus or arsenic used for the same purpose. It is also used as a deodorizer and disinfectant and as a preservative for wood. The ordinary soldering fluid used by plumbers and metal-workers is an impure sulphide.

Symptoms.—When taken internally in large doses, it acts as a violent corrosive, irritant poison, the most marked symptoms being excessive burning in the mouth, throat, œsophagus, and stomach, vomiting and purging, the discharged materials containing blood and mucous membrane.

Dose.—Death has occurred from the taking of various doses from 2 drachms to 2 ounces, and the period elapsing before death varies greatly. Taylor records a case in which death resulted within four hours.

Postmortem Appearances.—The tongue, mouth, and throat will be found shrivelled, somewhat leathery in appearance, and covered with a white eschar. The œsophagus and stomach will present the appearances found after swallowing any of the strong corrosive poisons. The mucous membrane, however, has a more leathery appearance than is common from the other poisons. A considerable amount of mucous froth will be found in the upper air-passages. The lungs and kidneys are congested.

Tests.—The tests for the chloride are similar to those for the sulphate.

Illustrative Case of Zinc Chloride Poisoning.—Tuckwell (*British Medical Journal*, London, 1874, ii. 196) reports a case of poisoning with Burnett's fluid. Woman, aged twenty-one years, took about three parts of a teacupful of Burnett's solution on the morning of February 2. Immediately after swallowing the fluid she was seized with a violent burning pain at the pit of the stomach and vomited the contents of the stomach. She was given an emetic and admitted to the hospital about six hours after taking the poison. She was suffering from a feeling of great faintness, and a burning pain at the epigastrium and under the left ribs. The throat was sore, and she had some difficulty in swallowing. She retched frequently, but there had been no action of the bowels. Lips, mouth, and tongue were unaffected; but the

Tests.—Copper or any of its salts may be readily recognized by their color whether in solid form or in solution. A solution of any of the salts of copper will present a bluish or grayish color. By this means alone it is possible to recognize its presence. There are a few other salts which produce somewhat similar color. Some of the salts of cobalt are blue, some of those of nickel, chromium, and uranium being green. When copper or its salts are heated, they turn a very decided green color, and when fused on charcoal with dry sodium carbonate globules of copper are obtained.

More or less of the copper will be precipitated by its union with albumin, but it may be broken up in an acid solution, so that in such solutions there is almost always a sufficient amount of copper salt in solution to furnish the greenish color, metallic taste, etc. After such a solution is filtered, it will respond to the ordinary copper tests, the most important of which are ammonium hydroxide, which produces a bluish-white precipitate which is soluble in an excess of the test, forming a deep violet-blue liquid. Potassium ferrocyanide in a very dilute solution gives a dark-red precipitate. Sulphuretted hydrogen and ammonium sulphide give a dark-brown precipitate. If a piece of polished iron or steel be suspended by a thread in a solution of copper slightly acidulated with sulphuric acid, it is coated with a red layer of copper. If this metal be then washed, treated with ammonia, and exposed to the air, it becomes blue, and may then be tested with potassium ferrocyanide.

Illustrative Case of Copper Poisoning.—Maschka (*Handb. d. gericht. Med.*, Tübing., 1882, ii. 291) mentions a fatal case of acute poisoning by sulphate of copper. Boy, sixteen years old, took on October 11, an unknown quantity of powdered sulphate of copper mixed to a paste with water. A half hour afterward he was carried into the hospital suffering with severe vomiting and great weakness, thirst, contraction in the throat, choking, and pain in epigastrium. Face was pale, lips blue at the angles of the mouth, tongue coated and bluish in color. Epigastrium sensitive on pressure. Temperature of skin was diminished, extremities cold, nails

vented from perforating, partly by the spleen, which formed the floor of the ulcer, partly by adhesions which passed from the spleen to the stomach, and were recent and thin. Small intestine: duodenum was congested and bile-stained. Jejunum and ileum were deeply congested throughout. The solitary follicles were swollen and bright red. Large intestine: cæcum was congested. Mucous membrane of the large intestine, from the ascending colon to the rectum, was a dull leaden color, with here and there some of the deep red seen in the small intestine. A considerable quantity of greenish pultaceous fecal matter was contained in the colon. Liver was large and swollen. Surface was smooth, greasy, soft and doughy, of a pale-fawn color. On section it was found to be soft and greasy and of the same color as the surface. Gall-bladder was distended with bile. Pancreas was of the same color as the liver, evidently fatty. Kidneys were large, swollen, and buff-colored. Capsule stripped off too easily. Cortex was increased in thickness and buff-colored; pyramids were deep red, offering a marked contrast to the cortex.

Microscopical Examination.—The liver, kidneys, and heart were found to be in a state of advanced fatty degeneration.

BISMUTH.

Bismuth Subnitrate ($BiONO.3H_2O$) is a heavy white powder, permanent in the air, odorless, almost tasteless, with a slight acid reaction, insoluble in water or alcohol. It is readily soluble in the stronger acids, from which it is precipitated by water. Bismuth is largely used in medicine and as a cosmetic. The medicinal dose is from 5 to 30 grains or more. Taylor reports that of five samples bought at various apothecaries arsenic was present in three. Certainly arsenic is commonly found in the ordinary bismuth of commerce. A number of cases of poisoning have occurred from the taking of large quantities of bismuth, and it is at least probable that the poisonous effects were due rather to contamination by lead carbonate or arsenic than to the specific action of bismuth.

villous, and easily detached. On detaching it the muscular coat was exposed. Otherwise the mucous membrane was normal. The mucous membrane of the small intestine was pale and not abnormal. That of the large intestine was swollen and of a pale-gray color. The large intestine contained some thin slimy feces.

ZINC (ZINCUM).

Zinc occurs in nature usually in the form of sulphide, called blende, and as a carbonate and silicate, which is usually called calamine. Red oxide of zinc and a mixture of zinc oxide with manganese and iron oxides, which is known as Franklinite, are also mined and worked for zinc.

Properties.—Zinc has a bluish-white color, a peculiar taste, and a perceptible odor when it is rubbed. Its texture is laminated, and it breaks with a crystalline fracture. It is not especially malleable. When perfectly pure, it may be reduced to thin leaves at the ordinary temperature, but the zinc of commerce requires to be heated to a temperature between 212° and 300° F. to be rolled into sheets. It is extremely soft when in a pure state. It has a specific gravity of 6.9, and may be almost completely dissolved in warm dilute sulphuric acid.

Action.—Zinc in a metallic state is inert, but, like copper, it may be transformed by the gastric juice into the form of one of its poisonous salts. Most of the soluble salts of zinc are poisonous, and in the commercial form it is very apt to contain arsenic. Poisoning by zinc is comparatively rare. The most important salts from the toxicological point of view are the sulphates and the chlorides.

ZINC SULPHATE ($ZnSO_4 \cdot 7H_2O$).

Zinc Sulphate occurs in commerce usually in a somewhat impure state, mixed with iron, copper, and lead sulphates, and in this condition is known as white vitriol.

Properties.—When pure, it occurs as small colorless rhombic

Postmortem Examination.—The tonsils, uvula, pharynx, and epiglottis were gangrenous; the larynx was spotted black; the œsophagus livid; stomach much inflamed, with numerous purple pimples; the whole intestinal canal red, and here and there gangrenous, especially at the rectum. The inner surface of the heart was bright red. Brain and kidneys healthy.

Case II.—Wilson (*New York Medical Journal*, 1894, lix. 87) reports a case of chronic poisoning by bismuth subnitrate. Girl, fifteen years old, received a burn of the third degree, covering an area sixteen by fifteen inches on her back, on April 16. She was admitted into the hospital on June 2. She had been treated outside from the time of the accident until her admission. The wound was scraped and cleansed with corrosive and dressed with bismuth subnitrate (Squibb's). The wound was dressed every second day until June 10, when the dressing was discontinued, the following signs and symptoms having been discovered: a black line along the margin of the gums, involving those of both the upper and lower jaws; headache, nausea, vomiting, paleness of the face, a urinous odor of the breath, elevated temperature, increased pulse, and increased frequency of micturition. The urine was light in color, specific gravity 1012, acid reaction, and contained a small amount of albumin. Œdema and pain of the lower extremities and some cutaneous irritation of the upper limbs, with a marked diarrhœa, existed and continued until she died on June 18. The bismuth was tested for lead and arsenic, which were not found to be present.

TIN (STANNUM).

Stannum is found as a metal generally distributed over the world. It is usually extracted from the native oxide, but is sometimes found as almost pure metal.

Properties.—Tin is a malleable, rather soft metal, of a silver-white color, undergoing a slight superficial tarnish, having very little taste, and giving off a peculiar odor when

accidental poisoning by sulphate of zinc. Woman, aged twenty-five years, drank a solution of an ounce and a half of sulphate of zinc believing it was Epsom salts. She immediately vomited, and then became affected with almost incessant retching and purging for half an hour, which continued afterward at short intervals for three hours, and then gradually diminished. Pulse was frequent and small, and extreme prostration existed, accompanied with restlessness and anxiety; temperature of the skin was diminished; great pain in the abdomen, limbs, etc.; there was a sensation of burning in the throat and stomach. As the prostration increased the pain ceased, and she died thirteen and a half hours after taking the poison. Her mind was clear to the last.

Postmortem Examination (*forty hours after death*).—Great lividity of the external surface of body; congestion of the brain and its membranes; congestion of the lungs; heart flaccid, right cavities filled with black thick blood; inner surface of the stomach covered with yellowish pultaceous matter, on the removal of which a uniform yellow-ochrous color was observed, except toward the greater curvature, where it became reddish; a gelatiniform ramollissement of the mucous membrane prevailed, exposing in some parts the submucous cellular tissue. Small intestine was somewhat injected and contained yellowish material.

ZINC CHLORIDE.

Zinc Chloride (Butter of Zinc, $ZnCl_2$) occurs as a white, crystalline powder or in white opaque pieces, very deliquescent, odorless, having a caustic, saline, and metallic taste and an acid reaction. It is very soluble in water and in alcohol, forming a clear but faintly opalescent liquid. The addition of a few drops of hydrochloric acid removes the opalescence.

Zinc chloride has been largely **used medicinally** in the form of so-called "cancer pastes," on account of its strong corrosive and caustic action. As an ingredient of such pastes it has an advantage over most others in that its absorption is not apt to set up constitutional symptoms as is the case with

impossible. From this time he continued to improve, and at the end of a month was in his usual health and spirits.

CASE II.—Luff and Metcalfe (*British Medical Journal*, London, 1890, i. 833) report four cases of tin poisoning caused by canned cherries. Man, aged eighteen, at 7.30 A. M., January 17, ate twenty-two cherries together with some of the juice, taken from a can of cherries. An hour and a half later he was attacked with nausea and abdominal pain, followed within a few minutes by vomiting and diarrhœa; he was very drowsy all the morning, but did not lose consciousness. Pulse was feeble, very irregular and rapid. He suffered from severe abdominal pain all the afternoon, and at 4.30 P. M. was in a condition of extreme collapse, with marked cyanosis and a pulse scarcely perceptible at the wrist. Under treatment he reacted and at 8 P. M. vomited. At 9 P. M. he retained iced milk and soda water and the diarrhœa had ceased. Evening temperature 100.8° F. The next morning the temperature was normal, and the patient was practically well.

Chemical examination of the remainder of the can of cherries revealed the presence of tin in solution in the juice. It was estimated that a pint of the juice contained 60.4 grains of the malate of tin.

IRON (FERRUM).

From a toxicological point of view the only two salts of iron which are of importance are ferrous sulphate and ferric chloride.

FERROUS SULPHATE.

Iron Sulphate (Copperas, Green Vitriol, $FeSO_4.7H_2O$) occurs in the form of large, pale bluish-green, monoclinic prisms, efflorescent and absorbing oxygen on exposure to air, without odor, having a saline taste and an acid reaction, very soluble in water, but insoluble in alcohol. Iron sulphate is commonly used in the arts and manufactures, and has been to a certain extent employed in medicine. It is a sharp astringent, and has been used in various forms of sepsis and

soft palate, uvula, tonsils, and pharynx were inflamed. There was much tenderness on pressure at the epigastrium. Pulse 144, very feeble. February 4 she had severe pain in the epigastrium and left hypochondrium. There was less vomiting, but still a little retching. Mucous membrane of the soft palate was covered with a white film. A slough was separating from the right tonsil and uvula. She had had no action of the bowels. The urine was free from albumin. March 9 pain and vomiting, which had abated, returned. She suffered occasionally from attacks of tetanic spasm in the right forearm and hand. April 2 vomiting and pain had both increased, and she was rapidly losing flesh. She was taking nothing but ice by the mouth and having four injections of strong beef-tea and brandy in every twenty-four hours. In spite of this the vomiting continued and was not influenced by the strongest remedies. The vomitus contained a considerable quantity of altered blood. May 29 there was extreme emaciation; gums spongy; peculiar fetor of breath. Trunk and extremities had a strange bluish mottled appearance, from innumerable petechiæ and vibices. Skin of legs was covered with thick scales. Intellect was clear by day, but she wandered at night. Her voice was reduced to the faintest whisper. She retched at intervals and vomited a greenish fluid. Pulse 130, scarcely perceptible. Temperature 96° F. She lived 116 days after swallowing the poison, during which time the bowels moved only three times.

Postmortem Examination (*seventeen hours after death*).—Body was greatly emaciated. Surface of trunk and extremities was thickly covered with ecchymoses. Muscles were pale and wasted. Omentum was shrunken and filmy, and devoid of fat. Heart was pale, soft, and flabby. There was a mere trace of fluid in the pericardium. Lungs healthy. Stomach: with the exception of the cardiac orifice, the whole of the mucous membrane was of a deep-red color, thickened and softened. This redness was uniformly intense as far as that part of the fundus which lay in contact with the spleen; here it was deeper than elsewhere, and there was an ulcer which had penetrated the coats of the stomach, but had been pre-

seen in the evening the patient was in a collapsed condition; pulse was imperceptible, respiration rapid, pupils dilated; lying quietly and groaning occasionally. It died soon after.

CASE II.—Chevallier (*Annales d'Hygiène publique*, Paris, 1851, xlv. 155) reports a case of homicidal poisoning by sulphate of iron. The victim, a man, was seen alive on Thursday evening and was found dead Sunday morning. His wife said that he had complained of pain in his side, in consequence of which he had died.

Postmortem Examination.—There were discovered, besides some slight lesions of the digestive canal, adhesions of the pleura and softening of the lung.

Chemical examination revealed the presence of sulphate of iron in the vomitus, stomach contents, stomach, and lung, and the presence of sulphuric acid in the fecal matter from the intestines.

FERRIC CHLORIDE.

Ferric Chloride (Iron Chloride, Iron Muriate, $Fe_2Cl_6.12H_2O$) is commonly met in medicine and pharmacy in the form of the tincture. It is **used in medicine** as a tonic and astringent, and in large doses acts as a violent corrosive poison with symptoms much like those of hydrochloric acid. Christison reports a case in which a man, taking by mistake 1½ ounces of the tincture, at first rallied, but died in about five weeks, having all the symptoms of poisoning by hydrochloric acid. Taylor reports an instance in which violent purging occurred within a few moments after the taking of a fluidrachm of the solution. Like the sulphate and chloride, it is not uncommonly given to women with the idea of bringing on an abortion, and for this purpose it is frequently combined with aloes.

Symptoms.—The symptoms are similar to those produced by ferrous sulphate, but when taken in large doses the action is more active and is not unlike that produced by hydrochloric acid.

Treatment is the same as that for ferrous sulphate.

Symptoms.—When poisoning occurs from the taking of large doses of bismuth, the symptoms presented are those of a violent irritant poison, and, as has been said, it is at least possible that these symptoms are due to arsenic or lead. After the taking of a large dose or of repeated small doses the breath has a distinct garlicky odor. This has also been ascribed by certain authors to the presence of arsenic as a contaminant.

Dose.—On account of the insolubility of bismuth in anything but the strongest acids, it is usually held that the bismuth itself is not absorbed into the circulation, and for that reason it must act mechanically if it does at all. Doses of 1 to 2 ounces have been taken without serious effect, and drachm doses are not uncommon. Death has, however, resulted from the taking of an ounce. It would appear that the fatal effects do not depend so much upon the amount taken as upon the degree of contamination.

Tests.—Sulphuretted hydrogen gives a black precipitate from which metallic bismuth may be obtained by the aid of a blowpipe.

Illustrative Cases of Bismuth Poisoning.—CASE I.—Kerner (*Heidelb. klin. Ann.*, 1829, v. 348; Christison, *On Poisons*, Philadelphia, 1845, p. 384) reports a case of fatal poisoning with bismuth *trinitrate*. A man took 2 drachms of the trinitrate with a little cream of tartar, by mistake. He was immediately attacked with burning in the throat, brown vomiting, watery purging, cramps, coldness of the extremities, and intermitting pulse, then with inflammation of the throat; had difficulty in swallowing; membrane of the nose was dry, and a constant nauseous metallic taste was present. On the third day he had hiccough; breathing was laborious; hands and face were swollen, and there was suppression of the urine which had been present from the beginning. On the fourth day swelling and tension of the abdomen were added to the preëxisting symptoms; on the fifth day salivation; on the sixth delirium; on the seventh swelling of the tongue and enormous distention of the abdomen; and on the ninth he expired. The urine continued suppressed until the eighth day.

at the centre was covered with green bilious mucus, and the borders with a black, muddy appearing material, consisting of a black pulverable substance and the mucus from the mouth. Œsophagus was pale and covered with the same black material. Larynx and upper part of trachea contained a small quantity of frothy mucus, slightly tinted with blood. Mucous membrane of the larynx and trachea was hyperæmic. Lungs: sound and crepitant. The blood in the large vessels of the lungs was black and fluid. Heart and pericardium normal. Blood in the large vessels was black and fluid. Blood in the large veins was also black and fluid. Stomach: external surface pale. Distended with gas and black colored fluid. The fluid contents were of a greenish-black color, with a briny odor. Mucous membrane was pale, slightly soft, and covered with the same black material found elsewhere. Intestines: duodenum was of a uniform black color, due to the liquid contents, which were similar to that found in the stomach. Small intestine was pale and slightly distended with gas. Jejunum was of a black color, due to the same black material already referred to. The black material diminished in intensity as the large intestine was approached. The lower part of the small intestine contained a quantity of green bilious mucus. Large intestine was distended with gas, was pale, and contained a quantity of green mucous substance. Mucous membrane was pale, discolored, with some subacute alteration. Liver was enlarged. The external surface in some places was a bright-red color, while in others it was a livid red. There were traces of hyperæmia. On incision a quantity of black fluid blood escaped. Spleen hard and shrunken. Kidneys enlarged, hyperæmic, and black in color. Bladder empty. Peritoneum: veins were gorged with blood. Mesenteric glands were hard and gorged. The greater and lesser omentum and the mesentery on a level with the duodenum and jejunum were of a black color, probably from absorption. Chemical examination revealed the presence of iron in large quantities, which were certainly abnormal, in all of the viscera.

rubbed. It is used in the arts very largely, both in its pure form and in combination, when it may appear as bronze, bell-metal, pewter, and solder. It is used in the amalgam for looking-glasses, and in the form of stannous chloride in the process of dyeing. The chlorides are the only forms in which it is of toxicological importance. As they are used commonly in the arts, they have been taken not very infrequently by mistake, and under such conditions result in acute poisoning.

Symptoms.—The symptoms resulting from the taking of any of the soluble salts of tin, especially the chloride, are those of the metallic irritants.

Postmortem Appearances.—Postmortem appearances are similar to those produced by any of the metallic irritants, but in a rather mild form.

Treatment.—Like mercury, tin forms with albumin an insoluble compound, but is also insoluble in alkalies. For that reason the best chemical antidotes are eggs, milk, or any of the mild alkalies. The stomach should be emptied and the symptoms treated as they present themselves.

Tests.—Sulphuretted hydrogen precipitates a dark, chocolate-colored perchloride of tin from this solution. Chloride of gold gives a purple precipitate, and if a piece of zinc be introduced, metallic tin will be deposited upon it.

Illustrative Cases of Tin Poisoning.—CASE I.—Hazeltine (*Boston Medical and Surgical Journal*, 1845, xxxi. 38) reports a case of poisoning with bichloride of tin. Boy, aged fourteen years, swallowed a quantity of the dyeing fluid containing bichloride of tin. When seen, one hour after taking the poison, he had great pain in his stomach, and had vomited a quantity of thick, slimy mucus, of a dark-green appearance. His mouth and fauces were severely corrugated, he could scarcely swallow, and his mouth felt hard and leathery. A cold, clammy sweat broke out, his pulse became indistinct and fluttering, and a fatal collapse seemed to be approaching. He reacted to treatment, however, and the next day complained of severe pain and great soreness of stomach and bowels. Swelling of the mouth and fauces rendered swallowing almost

mucous membrane was pale, except one small point of ecchymosis, and exhibited a large patch of corrosion, interrupted transversely in several places, but extending from the cardiac opening along the greater curvature for four inches. It was half an inch wide at the cardiac end, and one and a half inches at the end nearest the pylorus, and was of a brilliant white color. In the duodenum and first twelve inches of the jejunum, the valvulæ conniventes presented a similar corrosion over nearly their whole surface, but of a grayer color. The other viscera were healthy. Heart was empty and contracted. White particles rubbed off the corroded patches in the stomach, and off the valvulæ conniventes, proved to be chloride of silver.

Illustrative Case of Gold Poisoning.—Stevenson (*Guy's Hospital Reports*, London, 1893, l. 127) reports a case of poisoning by terchloride of gold. A boy was admitted to the hospital at 2 A. M., October 22, in a state of collapse. At 11 P. M. on October 21 he had swallowed a quantity of the terchloride, probably about 10 to 12 grains. He was immediately taken sick. The matter first vomited was black in color. The last meal had been taken six hours before. The vomiting continuing the boy was sent to the hospital three hours after taking the gold salt. On admission the child was collapsed, with closed eyes, pallid features, and the face and extremities cold. The lips, tongue, teeth, and inner side of the right cheek were stained of a purplish-black hue (reduced gold). The fauces were injected but not stained. Pulse 130, and very feeble. White of egg in milk was given frequently, but was always rejected within five minutes and it was not until 10 A. M. that any of the egg and milk mixture was retained. Diarrhœa and vomiting had continued throughout the night. 10 A. M.: boy appeared in pain and there was tenderness over the epigastrium on pressure. He was very thirsty. Abdomen retracted but supple, and moved during respiration. He was decidedly improved and took notice. The vomited matter was free from blood, but contained a few small blackish shreds, which were of a fatty and granular character. The

inflammation as an external application, also used in the form of ointment as an application to certain skin diseases. It is a powerful disinfectant, and in the impure commercial form is sometimes used in water-closets, slaughter-houses, etc.

Symptoms.—When given in large doses, it acts as an irritant, but apparently not a very active one. The symptoms presented may be severe, but recovery has followed the taking of quite a large dose. It has been used in attempts to produce abortion, and as a result of its use symptoms of poisoning have followed. The vomitus and discharges from the bowels are usually stained black.

Treatment.—Alkaline carbonates form with iron a bland, non-irritating salt, and for that reason may be used as an antidote. The stomach should be emptied and the symptoms treated as they present themselves.

Tests.—Any of the ferrous salts, of which ferrous sulphate is a type, respond to the following tests: First. The alkalies produce a white precipitate, turning later to a greenish brown. Second. Potassium ferrocyanide gives a white precipitate, which later changes through a light blue to a dark blue. Third. Ammonium sulphide gives a black precipitate.

Illustrative Cases of Ferrous Sulphate Poisoning.—CASE I.—Fitts (*Atlanta Medical and Surgical Journal*, 1888–89, 3 s., v. 198) reports a fatal case of poisoning by copperas. A child aged five years was given a dose of about 10 grains of copperas as a remedy for intestinal worms. Soon after taking the copperas it vomited, and shortly afterward fell asleep. About five or six hours later it awoke, making a strange noise and unable to speak. It was apathetic and had very severe griping pains in the bowels every one or two minutes. Pulse 110 and rather forcible. Vomiting was promoted and the pains ceased. The next morning it seemed to be quiet, and it made no effort to speak or take notice of what was occurring around it. Pulse 120. A dose of castor-oil was administered and it rested quietly until the oil took effect, which was about twelve o'clock, when the griping pains returned to the bowels and they increased in severity until the child went into convulsions, lasting several hours. When

deprives frogs of the power of voluntary motion by acting on the motor centres, but at the same time excites spasmodic movements resembling those made in volition. The irritability of the paralyzed muscles is sensibly diminished, but not lost until death. The heart muscles are unaffected. 2. In mammals it produces vascular paralysis, the result of an altered state of the peripheral extremities of the nerves. Intravenous injection in mammals was shortly followed by copious fluid diarrhœa, sometimes containing clear blood. Apathy and feebleness then set in, and were followed by complete paralysis of the limbs. Urine was copious at first and in the later stages of the poisoning contained some blood. The blood-pressure steadily sank until death took place, with the exception of a short time at the beginning, when the pressure rose in consequence of some irritation of the cervical spinal cord. There was complete peripheral paralysis of the muscular tissue of the bloodvessels, analogous to that observed in arsenic poisoning. The intestinal muscular tissue was not affected, as only a short time before death brisk peristaltic movements were observed. Autopsy revealed a high degree of hyperæmia of the abdominal organs, with ecchymoses of the mucous membrane of the stomach, intestines, and bladder. The vomiting, diarrhœa, bloody stools, hyperæmia of the abdominal organs and ecchymoses of the stomach, intestines, and bladder, were regarded as effects of the same cause.

CHROMIUM.

Chromium is rather widely distributed, but an uncommon metal, occurring in nature largely in the form of oxide. When pure, it is a brittle metal, grayish white in color, somewhat like platinum, with some lustre and sufficiently hard to scratch glass. It does not change on exposure to the air and is with difficulty affected by acids. All the chromium salts are more or less poisonous; the only two forms in which the metal is in common use are chromic acid and potassium bichromate.

Dose.—From 1 to 2 ounces has produced death in a number of cases.

Postmortem Appearances.—The postmortem appearances are similar to those found after any of the irritant poisons.

Tests.—The ferric salts, of which the chloride is a type, are reddish or brownish in solid form and when in solution. First, potassium ferrocyanide gives a greenish precipitate; in smaller amounts the fluid is colored blue. Second, alkalies give a reddish-brown precipitate. Third, sulphuretted hydrogen gives a white precipitate of sulphur and changes the ferric salts to the ferrous. Fourth, tincture of galls gives a bluish-black precipitate. It should be remembered that iron is naturally found in the body as part of the hæmoglobin in the blood, and when it is found in cases of supposed poisoning it will be necessary to decide as to whether the metal so recovered is or is not from that source.

Illustrative Case of Ferric Chloride Poisoning.—Bérenger-Férand and Porte (*Annales d'Hygiène publique*, Paris, 1879, 3 s., i. 314, Case I.) report a case of poisoning by perchloride of iron. Man, aged thirty years, on May 14, at 8.30 P. M. partook of some punch containing the poison. At 9 P. M. complained of malaise and a heavy stomach. During the course of the night he had diarrhœa, acute abdominal pain, and great weakness. At 4 A. M. he was found lying on the floor of his chamber, unconscious, with loud respiration, and did not respond when spoken to. A physician arrived nine hours after the ingestion of the poison and found the patient in a state of collapse. He promoted vomiting and ordered leeches, but in vain. The diarrhœa returned with increased violence, and the patient died at 10 A. M., thirteen hours after taking the poison.

Postmortem Examination.—Body was of a general icteric color, more especially marked on the face. Cadaveric rigidity very pronounced. Brain: the cerebral membranes and meninges were gorged with blood; the vessels of the pia mater were injected; encephalon was hyperæmic in spots. Mouth: the vault of the palate, mouth, and pharynx were of a uniform red color and covered with bloody mucus. The tongue

toms are vomiting and purging. The stools have been noted to be a peculiar grayish color, and the vomited matter yellowish. The pupils are usually dilated, the urine concentrated or suppressed, muscular cramps in the extremities are commonly found, and great prostration is the rule. Where life persists sufficiently long, periosteal swellings are usually found.

Dose.—As in the case of the other irritants, the danger depends to a great extent upon the concentration: 2 drachms have caused death within four hours, while 2 ounces have been taken, as in the case reported by Taylor, where it was mixed with pearl ash, and recovery has followed.

Postmortem Appearances.—The blood is as a rule thin and dark red. The œsophagus, stomach, and upper intestine are congested and inflamed; the stomach marked with patches of dark-red discoloration.

Tests.—When the salt is in fairly concentrated solution, its red color will be suggestive. Contents of the stomach, or other fragments of tissue should be digested with strong hydrochloric acid; the solution is then boiled and filtered. Ammonium sulphide will produce a black precipitate if the chromous salts are present, and a greenish-gray precipitate if the chromic salts are present. A similar color will be produced from the chromic salts with ammonia, while a blue precipitate turning green will follow from the chromous salts. Silver gives a crimson precipitate with the chromous salts.

Illustrative Case of Chromium Poisoning.—Priestly (*Journal of Anatomy and Physiology*, London, 1876–77, xi. 297) experimenting with neutral chromate of sodium gives the following results: "One to three grains CrO_3 in the form of neutral chromate of soda is a powerful poison for rabbits and guinea-pigs, producing death in from four minutes to thirty minutes, if injected at once into veins; and in from forty to fifty minutes when introduced beneath the skin. Death is preceded by spasms or convulsions, and violent retching, which commences a few minutes after the injection of the poison. In frogs muscular tremors, tetanic contraction of the pectoral

SILVER, GOLD, AND PLATINUM.

The salts and preparations of these three metals act, when taken into the animal economy, as irritant poisons. Poisoning by them, however, either criminal or accidental, is extremely rare. The symptoms presented are very similar and closely resemble those from poisoning with any of the stronger irritants. The treatment is that for any of the common irritants.

Illustrative Case of Silver Poisoning.—Scattergood (*British Medical Journal*, London, 1881, i. 527) reports a case of poisoning by nitrate of silver. Child, aged fifteen months, accidentally swallowed a stick of nitrate of silver, three-quarters of an inch long, at 9.30 A. M. Almost immediately the child vomited some oily matter, supposed to be cod-liver oil and milk, the oil having been taken after breakfast. When the vomiting had ceased common salt was given in considerable quantity, after which the child was slightly convulsed. Vomiting commenced again, and the vomitus had a white curdy appearance, and no doubt was principally chloride of silver. Vomiting and convulsions occurred at short intervals until 11.30 A. M. At that time there was a copious liquid stool, containing a quantity of the white curdy substance. At 1 P. M. the child fell into a composed sleep which lasted for half an hour; after which convulsions returned with increased violence, and continued until 3 P. M. The extremities then became cold, the face pinched, skin clammy, and the pulse almost imperceptible; and the child died in violent convulsions at 3.30 P. M., six hours after swallowing the poison.

Postmortem Examination (*twenty-five and a half hours after death*).—Body well nourished; cadaveric rigidity well marked; expression of countenance placid. Under the tongue was a small hard swelling, ulcerated on the surface, corresponding to the orifice of the Whartonian duct. There were two or three small patches of corrosion in the œsophagus. No marks of nitrate of silver in the mouth. The stomach contained two and a half ounces of an inodorous fluid. Its

canal below the cardiac orifice of the stomach. Semifluid grumous intestinal contents. Congestion of the kidney." In dogs and rabbits cloudiness of the epithelium, urinary casts, and albuminuria, have also been noticed to follow poisoning by chromic acid and neutral potassium chromate. "Stoppage of the heart in diastole. Chocolate coloration of the blood, which exhibited the bands of methæmoglobin when examined through a spectroscope. Muscles, nerve-trunks, and extremities, appeared to be sensibly normal."

Illustrative Case of Chromic Acid Poisoning.—White (*University Medical Magazine*, Philadelphia, 1889–90, ii. 54) reports a case of fatal poisoning by chromic acid used as a cauterant. A young woman, suffering with recurrent vegetations upon the genitals, was given the usual application of chromic acid solution of the strength of 100 grains to the ounce of water, about a half-ounce of the liquid used during the afternoon. After coming from under the anæsthetic she complained of a burning pain referred to the vulva; this continued through the night, during which time she was restless and thirsty. About 4 A. M. she arose to urinate and fell; she was assisted to bed and slept until 7 A. M. She continued thirsty but not feverish, all the morning, complained of nausea and refused food. When next seen, at 3 P. M., she was pale, with cold extremities, rapid pulse, complained of pain in the left hypochondriac region, and expressed fear of approaching death. Temperature in axilla 99° F. Under active treatment her condition did not improve, and she died at 6.30 P. M., twenty-seven hours after the application of the acid. Intellection was preserved to the last.

Postmortem Examination.—Body well nourished; marked postmortem discoloration on the back of trunk and limbs. Mass of venereal warts were dark in color and covered with offensive discharge. Thorax: both lungs crepitant; some hypostatic congestion posteriorly. Left lung adherent to the chest-wall and diaphragm. Right lung free. Pericardium contained about 2 drachms of clear straw-colored fluid. Heart: right auricle filled with currant-jelly clot. Small chicken-fat clot in left ventricle. Valves perfectly normal.

diarrhœa continued, thin and watery, brownish in color, contained numerous pellets of mucus and was free from blood. Circulation and respiration were normal. The stains about the mouth presented the following appearances: Both lips were darkened for about half an inch over each side of the mesial line at the junction of the mucous and cutaneous parts of the red of the lips. The outer parts of the lips and angles of the mouth were not stained. Tongue was white on the dorsum, but about a quarter of an inch from the edge on each side there was a longitudinal brown line of thin staining. On the right upper gum, just behind the posterior tooth was a dark stain. On the teeth, at their junction with the gums, was a discolored line. None of the stained parts were tender to the touch. The color of the stain was for the most part a very dark (black) purple. The palmar surfaces of the fingers and thumbs, and of one palm, were stained a lighter purple color. Around the nails the stains were black-purple. These stains were quite characteristic of reduced gold. Urine was normal in color and free from albumin. At 5 P. M. vomiting and diarrhœa had ceased. Next day, October 23, the child was fairly recovered and no constitutional symptoms supervened. On November 4 he was discharged quite well. Analysis revealed traces of gold in the earlier vomitus and feces, but none in the urine.

Illustrative Case of Platinum Poisoning.—Hoefer (*Gaz. méd., de Paris,* 1840, viii. 760) found that the chlorides of platinum were as poisonous as the chlorides of gold and mercury—the perchloride in 1 grain doses and the chloroplatinate of sodium in 2 grain doses. The perchloride in strong solution irritates the skin and occasions a slight eruption upon it. Internally in small doses, it irritates the stomach, causes headache, and gradually modifies the blood and secretions. According to Bryk, perchloride of platinum applied to the skin produces a thick, yellowish-white, dry eschar, surrounded by intense injection and even extravasation. Given to rabbits in the dose of 30 grains, it caused convulsions and death.

The experiments of Kebler (*Archiv f. exp. Path. u. Pharmakol.,* 1878, ix. 137) led him to conclude: 1. That it

nose, and on hands. Cerebral sinuses and veins of pia mater distended and containing dark-chocolate-brown blood of a syrupy consistence, without clot. Brain normal. Peritoneal cavity contained an ounce of dark-brown fluid. Liver was of an intense purplish-blue color and hyperæmic. Spleen dark red and firm. Capsule of the kidneys was nonadherent, and the parenchyma dark purple-red and very hyperæmic. Small intestine was moderately distended and contained a quantity of olive-green tenacious mucus, with shreddy pieces of a yellowish color. Mucous membrane showed evidence of irritation, but no loss of substance. Large intestine was firmly contracted and contained only a little mucus. Stomach contained a considerable quantity of greenish-yellow ropy mucus, the mucous membrane being stained a deep olive-green color, and covered with a loose membrane consisting of masses of cylindrical epithelium, which came away in flakes. Bladder contracted and quite empty. Lungs were of a dark blue-black color externally, crepitant, and contained a little blood of a dark chocolate-brown color. The cut surface was dark brown and very frothy. A crystal of bichromate of potash was found on the right side of the upper part of the œsophagus, and one on the opposite side at the same level. Tongue and the anterior surface of the œsophagus were stained a bright yellow. Heart contained three ounces of dark chocolate-brown fluid blood, but no clots. Skeletal muscles were all very rigid and of a dull-red color. Seventy-two hours after death rigor mortis was still marked. Chemical examination showed that the blood everywhere contained neutral chromates of sodium and potassium, especially in the veins of the portal system and in the heart and great vessels. The blood was found to be profoundly altered in color and consistence, and to have lost its alkaline reaction. It remained undecomposed and homogeneous in loosely corked bottles for nearly two weeks after the autopsy. Spectroscopic examination revealed the presence of methæmoglobin. The liver and kidneys were found to contain quantities of the poison. The mucous membrane of the stomach was of a green color, from the presence of reduced oxide of chromium.

CHROMIC ACID.

Chromic Acid (CrO_3) is obtained by the action of sulphuric acid on potassium bichromate. It occurs in the form of anhydrous acicular crystals, of a brilliant-red color, of metallic taste, deliquescent, and very soluble in water, forming an orange-red solution. It has been used in medicine as an antiseptic, disinfectant, and as an escharotic. As a caustic its action is rather more powerful than that of strong nitric acid, and if not carefully applied is apt to cause a very deep slough. When taken internally its action is that of a violent corrosive irritant, simulating that of strong nitric or sulphuric acid. Postmortem appearances simulate those from nitric and sulphuric acids and the tests will be spoken of under potassium bichromate.

POTASSIUM BICHROMATE.

Potassium Bichromate ($K_2Cr_2O_7$), when pure, occurs in the form of large, orange-red, transparent, four-sided, tabular prisms, odorless, having a bitter metallic taste and acid reaction, soluble in ten parts of water, insoluble in alcohol. In its pure form it is a caustic irritant. In dilute solution it is used in medicine largely as an antiseptic, and has been used internally in doses of about $\frac{1}{5}$ grain in the treatment of syphilis. In concentrated solution it is used as an astringent or an escharotic in the treatment of various local conditions, like tubercular granulations, warts, etc. It is used in the arts to a large extent for dyeing purposes.

Action.—When taken internally in concentrated solution or solid form, it is a very violent irritant poison. When applied externally, in solid form, its caustic action may be followed by local inflammation, ulceration, etc. A considerable number of deaths have been reported from its accidental taking, and Taylor reports one case in which it was taken with suicidal intent, and one in which it was taken in order to procure abortion.

Symptoms.—Like the other irritants, among the first symp-

Action.—Externally in solid form it is an irritant, and to a certain extent a caustic. When taken internally in concentrated form, it acts as a violent irritant poison, resulting in great pain and vomiting, followed by sudden dulness, great prostration, and death within a very short time. Death is said to follow a large dose within three minutes.

Symptoms.—As the solution is diluted the effect of its irritant properties will decrease or be even entirely wanting, and as these symptoms decrease in a dilute solution its more remote effects upon the nervous system present themselves. When it is dissolved in 20 parts of water, it usually possesses no corrosive and very little irritating power, but causes death by its action upon the central nervous system. There may or may not be vomiting; the symptoms of tingling and twitching in the legs, tetanic spasms, coma, prostration, and depression of the heart will be prominent. If life is somewhat prolonged, there may be swelling and soreness in the mouth, loss of voice, general pain in the head and neck, cramps and numbness in the legs, delirium, and convulsions. There are very few among the irritant poisons whose symptoms vary so much as those of oxalic acid.

Dose.—The dose sufficient to cause death varies much both in amount and concentration. Taylor reports a death from 1 drachm, and doses of from ½ to 1 ounce will usually cause death. In a concentrated dose death follows more quickly than after the taking of almost any other poison. Cases are reported of death at all periods from three minutes up. As a rule, the fatal result follows within an hour, but a considerable number of cases have occurred in which life was prolonged for periods up to several days.

Treatment.—In order to accomplish a good result, poisoning from oxalic acid must be treated within a very short time after the taking of the poison. The best **antidotes** are chalk, magnesia, or lime, which must be given in large and repeated doses. The combination of oxalic acid with these materials is bland and insoluble. The alkalies should not be used, as the combinations formed between oxalic acid and ammonium or potassium are equally soluble and equally poisonous with

muscles and the flexors of the fore limbs, and tetanic extension of the hind limbs on the application of slight stimuli, represent this class of symptoms. Convulsions are varied, or succeeded by paralysis of motion in mammals, and in frogs, as is usual, of respiration also. In frogs, too, the power of reflex action is speedily abolished." "The blood-pressure generally rises within ten seconds of injection of the poison into the jugular vein; but this rise speedily gives way to a fall, which begins from three-quarters to three minutes after injection. A downward tendency is steadily maintained until death, previous to which the blood-pressure becomes extremely slight. Meanwhile the pulse preserves a strict normality, save that, as the blood-pressure falls, it becomes somewhat deeper. With this exception it appears to be quite independent of the blood-pressure, maintaining its rapidity until the latter has reached a mean equal to one-half or one-third of the normal. Afterward, however, a peculiar modification begins to occur at irregular intervals; and continues to appear for longer or shorter periods. After a time it gives place to a pulse of normal character, but of less than the original rapidity. Again it returns; but it invariably disappears just before death, when the pulse gradually lengthens and weakens. This phenomenon gives one the impression of the heart stopping suddenly for the space of a beat, again setting up normal pulsation immediately afterward—as it were, 'slipping a beat.' These slips are interjected into the series of ordinary heart-beats without previous warning; and they do not seem to specially or at once, affect the mean blood-pressure. After these irregularities have set in, although the pulse may again become normal in appearance, it never regains its previous rapidity, but remains deep and slow."

Postmortem examination of the animals experimented on disclosed the following: "The reduction of the drug in the cellular tissues at the point of injection beneath the skin. Free exudation of fluids into the various cavities and spaces of the body. The muscles were of a yellow-brown color." "Congestion and ecchymoses of all parts of the alimentary

and vomiting was kept up by mustard and warm water. At first her pulse could not be felt, but the circulation was soon restored by stimulation. Vomiting continued through the night, and she passed much blood and mucus by the bowels. Milk was rejected. Pulse 104. Next morning she had great pain over the abdomen, and was very sick, her voice was very harsh; pulse 72. During the next two days she had less pain and sickness; her mind had always been clear; slept better; purged a little. On the 27th there was no purging, no blood in stools, tongue clean; slight headache, less pain, no sickness. On the 29th she was much worse; had severe pain across the abdomen, and had been purged a great deal. Constant sickness came on, and she died in a few hours, apparently from exhaustion.

Postmortem Examination (*twenty-three hours after death*).—Body fairly nourished; no lividity, slight rigidity of the extremities, tongue and mouth normal; epiglottis red and eroded on the under surface. Most of the mucous membrane of the œsophagus was stripped off, especially at the lower part. Stomach was congested and distended. At the lower part of the great curvature was a slough, irregular in shape, about the size of a crown piece. The wall was thicker than usual here, and the peritoneal coat was opaque. The slough had not begun to separate. All through the intestine the walls were congested and thicker than usual. In the lower part of the ileum, for about three feet, and leaving off suddenly about six inches from the cæcum, were numerous sloughs of an ochre-yellow color, and involving the whole of the bowel, and not Peyer's patches or solitary glands only. The serous covering was congested. No ulceration in the large intestine, but the solitary glands were enlarged. No peritonitis. Trachea and bronchi normal; lungs rather congested at their bases. Heart and liver healthy. The cortical portion of each kidney was rather swollen and œdematous, and in some of the tubes there was an increased number of cells. Mesenteric glands normal.

Abdomen: stomach distended, mucous surface shows numerous fine ecchymoses the result of vomiting. Section of duodenum shows biliary ducts patulous. Large intestine distended with gas, and containing fecal matter. Liver small; on section shows the nutmeg change. Gall-bladder distended with a very dark-colored secretion. Spleen flabby and pale. Kidneys the seat of passive congestion. Capsules strip off easily. Vagina: section of vagina shows mucous membrane dark-red in color, covered with a yellowish discharge with no evidence of contact of acid. Brain: dura thin, non-adherent; longitudinal sinus contains postmortem clot. Veins of pia mater swollen and congested. Choroid plexus injected.

Chemical examination of kidney and liver tissue revealed the presence of chromium, most likely sodium chromate. The tissue of the rectus muscle was free from chromium.

Illustrative Case of Potassium Bichromate Poisoning.—Ruttan and Lafleur (*Montreal Medical Journal*, 1888–89, xvii. 81) report a fatal case of poisoning by bichromate of potassium. Man, aged twenty-five years, took about 2 ounces of the bichromate in the solid form. He could not have taken the poison before 11.15 A. M. and a few minutes later he was found lying in an out-house vomiting, purging, and in great agony. When seen by a surgeon he was writhing with pain on the floor, speechless, his mouth hands, and clothes stained with greenish-yellow vomit; surface of body cold, face contorted and of a dusky hue, pupils unequally dilated, pulseless at the wrist, respiration very rapid and shallow, abdomen retracted and painful on pressure, and the knees drawn up to the body. The breath was cold, and the mouth contained a yellow, frothy mucus. He died a few minutes after reaching the hospital, less than an hour from the time of taking the poison. When seen one hour after death, cyanosis was intense over face and neck, and pupils were widely dilated.

Postmortem Examination (*forty-eight hours after death*).—Intense purplish-blue lividity of face and upper part of neck; pupils contracted to a pin's point. Postmortem rigidity very marked. Bright-yellow staining of skin around mouth and

flamed gut, and in addition there was a small similar patch between the base of the left lung and the diaphragm." Mesentery was free from lymph, and the glands were not enlarged. No free fluid in the peritoneal cavity. Œsophagus showed a few shallow erosions. Several patches of subserous hemorrhage were found in the stomach, and the mucous membrane was covered with a layer of rather tenacious mucus. The mucous surface of the whole intestine showed signs of recent inflammation. The transverse and descending colon appeared to have suffered more than any other part of the intestine. Lungs were emphysematous, liver rather fatty, spleen soft. Heart, kidneys, pancreas, appendix and pelvic organs were normal. No evidence anywhere of tuberculosis.

Illustrative Case of Acetic Acid Poisoning.—Orfila (*Annales d'Hygiène publique*, Paris, 1831, vi. 163) reports a case of fatal poisoning by acetic acid. Woman, aged nineteen years, on May 7 at 11 P. M., while intoxicated, was heard complaining. She was followed, and at 3.30 A. M. the next morning, May 8, was found lying in the street, near a wine shop, suffering severely. She had convulsions and complained of her stomach. She died shortly after at 4.30 A. M. Anatomical and chemical examination proved the case to be one of poisoning by acetic acid.

Postmortem Examination.—Rigor mortis not present; slight meteorism of the abdomen; neck, shoulders, posterior part of trunk, and the extremities were of a violet color, due to infiltration of blood in the tissues of the skin. The mouth, lips, and nostrils were covered with a slightly brown frothy liquid, partly dried, and exhaling an odor of alcohol. Jaws were tightly closed; teeth white and not altered. Mucous membrane of the mouth was normal; tongue was leathery and of a brown color. Its glands were very apparent. The osophagus presented much the same appearances, only more pronounced, and was of a brownish-black color. It was not covered by any mucous membrane, liquid or false membrane. Stomach was distended, violet color externally, almost black toward the pylorus; its mucous membrane not destroyed, but grayish-white toward the cardia, brown to black toward the

QUESTIONS.

Describe poisoning by lead.
By copper.
By zinc.
By bismuth.
By tin.
By iron.
By silver, gold, and platinum.
By chromium.

CHAPTER VI.

VEGETABLE IRRITANTS.

OXALIC ACID.

Oxalic Acid (Acid of Sugar, $H_2C_2O_4.2H_2O$) occurs in small, colorless, prismatic crystals, odorless and of a very sour taste, slightly effervescent in dry air, fuses at 208° F., and entirely volatile at a red heat. This acid is very commonly distributed in nature in both the animal and vegetable kingdoms. In the forms of various oxalates it is found frequently in plants, especially in rhubarb, sorrel, dock, and lichens. It is very freely generated in the urine as a result of a modified action of the kidneys, and then it is deposited in the bladder as calcium oxalate, forming a calculus.

This acid is usually obtained by the action of nitric acid upon sugar. It may be formed by the action of the same acid upon molasses, rice, potato, starch, gum, wool, hair, etc.

On account of its frequent use in the arts, its common occurrence and cheapness, oxalic acid is frequently used as a means of suicide. It has also been accidentally taken in a large number of cases by mistake for Epsom salts, which it closely resembles in its crystalline form. It has been, so far as is known, very rarely used for homicidal purposes, probably on account of its extremely sour taste. Oxalic acid is used in medicine to a certain extent as a disinfectant. It is largely employed in the arts as a bleaching agent, and takes part in the composition of many cosmetics.

cine as a disinfectant, deodorizer, and antiseptic. When applied in crystalline or concentrated form, it acts as an anæsthetic and caustic. Taken internally it is a corrosive irritant and neurotic poison. It is rarely used in cases of homicidal poisoning, but on account of its wide distribution and common use it is frequently the cause of death in suicide, and not rarely as a result of accident. It has caused death when applied externally.

Symptoms.—When externally applied to the skin and mucous membrane, there is first a sharp pain followed by numbness, and a white discoloration, the last being due to coagulation of the albumin. When taken internally, there is intense pain in the mouth, throat, œsophagus, and stomach. The pupils are contracted and the conjunctivæ anæsthetic. As it is rapidly absorbed, the nervous symptoms soon present themselves: delirium, giddiness, and insensibility. The skin is cold and moist. The temperature falls, respiration is slow and labored; the pulse weak, rapid, and intermittent. Suppression of urine commonly occurs. If life is sufficiently prolonged, the urine becomes of an olive-green color. There may or may not be vomiting; if it occurs, it is usually frothy. Death may occur during coma or be associated with convulsions. The characteristic odor of carbolic acid will be noticed in the breath.

Dose.—The fatal dose varies very widely: 6 or 7 drops have caused serious symptoms in an adult; 80 grains have killed an adult, while recovery has followed the taking of much larger quantities up to 1 ounce. Taylor reports a case in which a girl of fourteen took 6 drachms of the dilute acid, and while she had most of the typical neurotic symptoms, she recovered without lasting effects. Death has frequently occurred within twenty minutes after the taking of a poisonous dose, and at least two cases are reported in which it followed within two or three minutes. Occasionally life persists for twenty-four to forty-eight hours after the taking of a fatal dose.

Treatment.—Sodium sulphate probably comes as near to being a chemical antidote as does any drug. The stomach

the acid itself. The stomach should be emptied and treatment directed toward overcoming the prostration and depression of the heart which follow its use.

Postmortem Appearances.—No matter what the size and concentration of the dose may be, there is always a greater or less amount of bleaching and softening of the mucous membranes; they may be covered with a soft brownish coat representing the discharges from the stomach. The stomach as a rule contains a dark-brown, more or less gelatinous fluid. The mucous membrane of the stomach will usually be pale and softened, in some cases presenting no signs of inflammation. It will usually be easily separated from the walls of the stomach, and will appear as if boiled. The intestines are usually congested if death has been delayed for even a few hours. The lungs and brain have been found congested. The heart is usually flabby, and may be either empty or full. The blood is dark-colored and fluid. The kidneys, where life has been prolonged, may exhibit a peculiar white line in their cortical areas, representing an accumulation of calcium oxalate.

Tests.—The contents of the stomach, having been digested with distilled water and then filtered, calcium chloride will give a white precipitate which is soluble in nitric acid. Cupric sulphate gives a bluish-white precipitate and silver nitrate a dense white precipitate, which on being heated becomes brown.

Illustrative Case of Oxalic Acid Poisoning.—Beale (*Lancet*, London, 1867, ii. 394) reports a case of poisoning by oxalic acid. Woman, aged thirty-four years, previously in good health, took voluntarily half an ounce of oxalic acid, on May 22. Directly afterward she felt a burning pain in the throat and epigastrium, and was giddy; in about fifteen minutes she was very sick; an hour afterward she was purged violently, and passed blood in the stools; she also vomited blood. On admission to the hospital she had severe pain in the stomach, retching, great thirst, cold extremities, sunken eyes, and pallid countenance. Chalk and water and carbonate of magnesium were given her, with the effect of lessening the pain,

Stomach was freely washed out with olive oil, mustard plasters applied to the chest and back, and ether injected subcutaneously. The breathing gradually became more stertorous and shallow, pulse more intermittent, and death took place at 1.35 P. M., preceded by profuse perspiration about the head and neck, but without convulsions.

Postmortem Examination (*twenty-six hours after death*).—There was marked lividity about the back. Postmortem rigidity of arms and legs was present. All the cavities of the heart and all the large veins were full of very fluid blood, of a rich mulberry color and faint carbolic odor; there were no clots of any description. Lungs were much congested and œdematous. Larynx and trachea were very much congested, the smaller arterioles being distinctly visible. There were some excoriations about the epiglottis, but none in the trachea or bronchi. At the bifurcation of the trachea a clot of yellowish mucus, smelling strongly of carbolic acid, was found. There was a faint smell of carbolic acid on first opening the abdomen. There was much general congestion present. The mucous membrane of the stomach was almost entirely eroded, and lay in lines along the posterior surface, looking and feeling like whipcord. Stomach contained oil mixed with carbolic acid. The mucous membrane of the œsophagus was gathered into longitudinal folds, and presented very much the appearance of "cigarette-paper"; there were no erosions. Intestines were very much congested and contained oil and carbolic acid. There were some slight erosions about the duodenum. Kidneys were congested, and smelt strongly of the acid. Bladder empty. Spleen was soft and pulpy, and of a deep "mulberry" color. Liver was congested. Brain congested, and there was some slight excess of fluid in the ventricles, with a doubtful, faint odor of carbolic acid.

CROTON OIL (OLEUM TIGLII).

Croton Oil is a fixed oil which is obtained from the seeds of *Croton Tiglium*, a small tree or shrub found in India. The active principle has not been isolated.

TARTARIC ACID, ACETIC ACID, AND CITRIC ACID.

Tartaric Acid, Acetic Acid, and Citric Acid are commonly used in the arts and to a certain extent in medicine, especially as a means of manufacturing a cheap substitute for lemonade, and in the making of effervescent drinks. Their use as poisons is not common, and so far as is known cases of homicide or suicide by their action have not been reported.

Accidental poisoning by their means are not uncommon, and when this occurs it is usually from taking them in mistake for some of the saline cathartics.

The **symptoms** presented are those of oxalic acid in a much milder form, the **fatal dose** being from 1 to 2 ounces, the treatment being similar to that for oxalic acid. The **postmortem appearances** are those presented after any of the irritant poisons.

Illustrative Case of Tartaric Acid Poisoning.—Trevithick (*British Medical Journal*, London, 1893, i. 1321) reports a fatal case of poisoning by tartaric acid. Woman, aged sixty-seven, took an unknown quantity of the acid, "about two teaspoonfuls," probably of considerable strength. Abdominal pain and vomiting set in almost immediately after the ingestion of the poison, and diarrhœa some hours later. When seen twenty-four hours after the onset of the symptoms she was suffering from intense abdominal pain, and screaming whenever she moved in bed. Pulse was fairly good, tongue very dry, temperature 100° F. On the fourth day the pulse began to fail markedly, and in the evening the patient became delirious and remained so until death. On the day before death the diarrhœa, which had been checked, recommenced. Death took place on the seventh day after taking the poison.

Postmortem Examination (*fourteen hours after death*).—Rigor mortis marked. "The serous surface of the small and large intestine was found coated with a layer of soft, butter-like lymph. The serous surface of the stomach appeared free from this. There were some patches of similar character on portions of the peritoneum which lay in contact with the in-

healthy, took by mistake one-third of a mixture containing olei tiglii ℥ij and olei terebinthinæ ʒij. Complained immediately of a feeling of intense burning in the gastro-intestinal tract, followed in fifteen minutes by copious vomiting. The matter vomited contained part of the oil. Dejections followed in twenty minutes after mixture was swallowed, and both vomiting and purging continued at frequent intervals until death took place. The discharges, though involuntary, were attended with great suffering. Prostration was extreme, resembling the collapse of malignant cholera. Thirst was very great. Mind was not affected, but for three hours before death vision was so much affected that he was unable to recognize acquaintances.

Postmortem Examination (*eighteen hours after death*).—Rigor mortis strongly developed. Ecchymosis over depending portions of body well marked. Pupils dilated. Congestion or hyperæmia of vessels of intestines. Chronic enlargement or hypertrophy of the mesenteric glands. Gastroïntestinal mucous membrane was inflamed. Solitary glands of small intestine were of a pearly appearance; Peyer's patches normal. Bladder contracted and containing a small amount of urine. Liver, kidneys, and spleen normal. Lungs congested. Right side of heart contained a large firm antemortem clot. Left ventricle empty; left auricle half-filled with semifluid blood.

ELATERIUM.

Elaterium is **obtained from** the juice of *Ecbalium Officinarum* (Wild Cucumber or Squirting Cucumber). It is usually found in the market in the **form of** thin, flat or slightly curved cakes of a greenish-gray color becoming yellowish on exposure to air, with a bitter, acrid taste. It is inflammable and so light as to float upon water. Its active principle *elaterin* composes about 44 parts in 100. Elaterium as found in commerce varies much in strength and quality, as it does in the amount of the active principle contained in it. It is used freely in medicine as a powerful drastic purgative, having much the same effect as croton oil.

pylorus, and contained about eight ounces of a brown slimy fetid liquid which yielded acetic acid on distillation. Heart and lungs normal.

Illustrative Case of Citric Acid Poisoning.—Stillé and Maisch (*National Dispensatory*, Phila., 1887, 54) give the following in regard to the physiological action of citric acid: "Experiments with citric acid on cats, rabbits, and other animals illustrate the necessity of caution in founding opinions upon such grounds exclusively. To these creatures citric acid is a powerful poison, lowering sensibility and the heart's force and producing violent tetanic spasms. That these phenomena are not occasioned by gastric irritation is proved by the absence after death of all inflammatory lesions of the stomach. The blood appears to have been unusually liquid. In man, on the other hand, not only are no spasmodic or other alarming symptoms produced by citric acid, but it does not diminish the coagulability of the blood; so far from this indeed, in the form of lemon-juice it is of all agents the most efficient in correcting that incoagulability of the blood which is characteristic of scurvy. When largely administered, it increases the acidity of the urine, causing a deposit of free uric acid. According to Langfeldt, 1 part of this acid in 2000 parts of water is sufficient to destroy all the animalculæ in the liquid that are not protected by a thick epithelial covering. Citric acid used habitually is very apt to corrode the teeth."

CARBOLIC ACID (PHENIC ACID, PHENOL, C_6H_5HO).

Carbolic Acid in its pure state occurs as minute plates or long rhomboidal needles, white or colorless, of a peculiar odor and an acrid, burning taste. Its specific gravity is 1.065. It is apt to be colored pinkish or brown under the influence of light and air, this change, it is thought, being due to the presence of ammonia in the atmosphere. It deliquesces on exposure to air and ultimately becomes liquid. When diluted, it has a sweetish taste and a neutral reaction. Carbolic acid is a product of the distillation of coal-tar. It is moderately soluble in water. It is largely used in the practice of medi-

eyes sunken, and the countenance was remarkably like that seen in cholera. At 5 P. M. the pulse was above 150, and irregular. She continued to vomit incessantly, and when seen at 2 A. M., June 3, the extremities were cold, pulse imperceptible, excessive tenderness over abdomen, with excruciating pain when fluids, which she attempted to drink, reached the stomach. No dejections and no urine had been passed since the first visit. She died at 3 A. M., thirty-six hours from the time the last pill was taken. The vomitus toward the last was darker and resembled turbid chocolate.

Postmortem Examination (*nine hours after death*).—On opening the abdomen the whole cavity seemed to be filled with the stomach, which was greatly distended. External surface of the stomach was of a grayish color and very dry. Vessels of the greater curvature were highly distended with dark blood. Mucous membrane was injected, but not corrugated. There were a few spots near the cardiac orifice that seemed to be abrasions or disorganizations. Stomach contained a quart or more of a dark-brown fluid. The whole of the intestines were highly inflamed and free from fecal matter with a slight exception in the cæcum. Colon was contracted to a very small size. Duodenum and jejunum showed much the same appearances, both externally and internally, as the stomach. Lungs normal. Other viscera normal.

CASTOR OIL (OLEUM RICINI).

Castor oil is a fixed oil expressed from the seed of *Ricinus Communis*. The castor oil plant is commonly found in the East Indies and Africa, and is grown for decorative purposes chiefly through North America and Europe. The oil itself is commonly used in medicine as a cathartic, but on account of its mild qualities has, so far as known, not been directly the cause of death. The seeds, however, on account of their attractive appearance have not infrequently been eaten by children, and fatal results have followed in some instances. These seeds when swallowed act as violent irritants to the gastro-intestinal tract, the poisoning being apparently due to

should be thoroughly washed out and a solution of lime, sodium sulphate, or soap introduced as a neutralizing agent. Emetics have little effect on account of the anæsthetic condition of the mucous membrane of the stomach.

Postmortem Appearances.—The lips, mouth, and œsophagus are usually white, and may be very soft and corroded, or hardened and corrugated. The stomach is commonly in the same condition, reddened and inflamed between the folds. The brain and lungs are generally congested. The ventricles usually contain fluid. The left ventricle of the heart is contracted and the right flaccid. The blood is dark colored and fluid. The bladder is usually empty and the urine dark olive green in color. The odor of carbolic acid is noticeable throughout the viscera.

Tests.—The odor is probably the most satisfactory test. When in solution, nitric acid gives rise to the formation of yellow crystals of picric acid. Ferric chloride gives a deep-violet color, bromine a whitish-yellow precipitate. Ammonia or chlorinated soda gives a deep purple. Solutions of carbolic acid have a very slight acid reaction, coagulate albumin, and give a transient greasy stain to white paper.

Illustrative Case of Carbolic Acid Poisoning.—Silk (*British Medical Journal*, London, 1881, i. 640) reports a fatal case of poisoning by carbolic acid. Man, aged thirty-nine, was admitted to the hospital about 12 noon, January 4, with a history of having taken about a wineglassful of strong carbolic acid about half an hour previously. He was in a state of profound coma; breathing markedly stertorous, 36 per minute, but regular; the breath smelt strongly of carbolic acid. The lips were shrivelled and white, and there were one or two excoriations about the angles of the mouth. Eyeballs were fixed and prominent; pupils equally contracted to a pin's point, and insensible to light or touch. Pulse was full and soft, occasionally intermittent, 120 per minute. Temperature was under 95° F. The surface of the body was cold and clammy, devoid of sensibility; the superficial and deep reflexes were completely destroyed. No convulsions or vomiting; and urine and feces were retained.

COLCHICUM (MEADOW SAFFRON, COLCHICUM AUTUMNALE).

Colchicum contains both in the bulb and in the seed a poisonous principle called colchicine. This plant is found in the temperate parts of Europe and northern Africa. It has not been much grown in America. Colchicum itself is obtained from the roots and the seeds more especially, although the stem, flowers, and leaves contain it to some extent. The active principle is obtained from any portion of the plant.

When taken internally in a therapeutic dose, it has a decided hydragogue action in most cases. In some, however, there is instead of this a marked increase in the perspiration and amount of urine.

Symptoms.—Aside from its cathartic action, when taken in large doses, it acts as a violent irritant to the digestive tract, and also presents symptoms of neurotic origin, the most marked general symptoms being abdominal pain, vomiting and purging, dilated pupils, cold, clammy skin, suppression of urine, and exhaustion. Death may be preceded by delirium and convulsions.

Dose.—The strength of colchicum varies greatly as it is found in commerce, this variation depending, to a very considerable extent, upon the time at which the plant is gathered. Early in the spring it is too young, and late in the fall the roots have been exhausted in furnishing nourishment to the plant. The proper period for collection is from the early part of June to the middle of August. In the early spring and fall the amount of active principle present may be reduced many times. Less than $\frac{1}{2}$ grain of colchicine is probably a fatal dose. Death may occur within a few hours or life may be prolonged for several days. Generally death follows within twenty-four hours.

Treatment.—Emetics, cathartics, and the treatment of symptoms as they present themselves. Tannic acid is a partial antidote, and the irritation of the mucous membranes should be treated by the application of soothing fluids.

Postmortem Appearances.—Inflammation of the stomach

Properties.—As found in the shops the oil varies from a pale yellow to a dark reddish brown, is viscid, with a faint peculiar odor, and hot, acrid taste, leaving in the mouth a disagreeable sensation which may persist for several hours. It has a specific gravity of about 0.950. When fresh, it is soluble in about sixty parts of alcohol, freely soluble in ether, chloroform, carbon disulphide, and turpentine, its solubility and therapeutic activity increasing with time. Croton oil is used in medicine as an external irritant and as a drastic cathartic, it probably being the most rapid and effective known.

Action.—If 1 or 2 drops be applied to the tongue of a comatose patient, its purgative action will usually be effected. As a purgative it is very apt to incite vomiting and severe griping pains. It acts with great rapidity, generally resulting in a movement of the bowels within an hour from its taking. When taken in an overdose, it acts as a powerful irritant to the digestive organs, resulting in prostration and death.

Symptoms.—A very considerable number of cases have been reported of accidental, and a few of homicidal, deaths from the taking of croton oil. The symptoms presented are usually those of gastro-intestinal irritation, followed by vomiting, purging, collapse, and death. In some instances there have been convulsions. When applied externally, it acts as a strong irritant, producing inflammation of the skin associated with an eruption which is usually pustular in character. The symptoms presented as a whole simulate very closely those of cholera.

Dose.—The medicinal dose for an adult is 1 or 2 drops. Fatal results have followed the taking of varying quantities from ½ to 2 drachms, and cases have been reported in which life was saved after the taking of ½ ounce. Death has occurred after varying intervals of from two to twenty-four hours.

Tests.—The oil may be separated from the stomach contents by ether. If this solution be evaporated to dryness spontaneously, the remaining oil may be tested.

Illustrative Case of Croton Oil Poisoning.—Denig (*Medical Record*, New York, 1875, x. 503) reports a case of fatal poisoning by croton oil: Man, aged twenty-six, strong and

ish clot. Ventricles quite empty. On the floor of the fourth ventricle a minute hemorrhagic spot was found. Rest of brain normal. Heart: right heart was moderately distended with clotted blood, left contracted and empty; a goose-fat clot was found in the right ventricle extending into the pulmonary artery. Valves and muscular structure intact. Coronary arteries normal. The right border and apex of the heart contained a number of hemorrhagic markings. Left pleural cavity normal. Lungs hypostatically congested. Very little œdema present. Right pleural cavity was almost obliterated. Bronchi of both lungs contained a small quantity of frothy, bloody mucus; trachea contained a small quantity of mucus. Thyroid gland enlarged. Œsophagus normal. Abdomen: about six ounces of bloody serum was found in the abdominal cavity. Spleen was small and pale. The pyramidal portion of the kidneys was congested, cortex normal, capsule stripped easily. Colon was quite empty, containing only a white, cheesy-like mass, spread evenly over the mucous surface. No ulceration or disease of the mucosa of the intestines. Small intestine was normal throughout. Stomach enlarged and distended with gas. It contained nearly a pint of liquid; mucous membrane was of a grayish color, and separated readily from the submucous structures. Liver was unusually pale and glistening, and its markings could not be made out. Bladder contracted; contained a small quantity of mucus. Rectum empty and very pale; vagina dark in color and contained some fluid blood. Examination of the stomach contents gave no reaction for colchicin. Liver not examined for the poison.

SAVINE.

Savine is obtained from the tops of *Juniperus Sabina*, which is an evergreen shrub from three to fifteen feet high, a native of Europe and the Levant. It is also said to grow wild in the neighborhood of the northwestern lakes in America. The ends of the tips and the leaves by which they are invested are collected in the spring and dried.

It has been used, as have most of the other hydragogue cathartics, for the bringing on of abortion. As a result of its use for this and other purposes cases of poisoning have occurred. While its use is associated with a certain amount of risk on account of its very powerful action, it is still used to a considerable extent as a cathartic, especially in cases of dropsy.

Symptoms.—The symptoms presented after the taking of large doses of elaterium are very similar to those following croton oil—irritation, inflammation of the gastro-intestinal tract, associated with vomiting, purging, and collapse.

Dose.—The medicinal dose of elaterium is from $\frac{1}{8}$ to $\frac{1}{2}$ grain. In the aged or infirm even so small a dose may have serious effects. A case has been reported in which $\frac{2}{5}$ grain caused death in a woman of seventy-two who was enfeebled by cardiac disease. One grain will usually cause serious effects, although certain individuals are able to take more without danger to life.

Tests.—Nitric acid is without effect, while sulphuric acid changes its color to a reddish brown.

Illustrative Case of Elaterium Poisoning.—Bartlett (*Medical Magazine*, Boston, 1835, iii. 25) reports a fatal case of poisoning by elaterium: Girl, aged eighteen, suffered from loss of power in one of her arms, for which the following was prescribed:

℞	Pulv. rad. rhei,	℈j;
	Extr. elaterii,	grs. iij.
M.	ft. Pil. No. 5.	

She was directed to begin with two pills, and to repeat one every three hours until she vomited. At 9 A. M., June 1, she took two pills, vomited once, and repeated a pill at 12 M. and again at 3 P. M. From this time she vomited incessantly at intervals of from ten to fifteen minutes a thin, bile-colored fluid. When seen at 3 A. M., June 2, she was still vomiting, pulse was feeble, small and frequent, countenance anxious, no pain over epigastrium on pressure. She had had six dejections. Opium in soda powders and a mustard plaster over abdomen were prescribed. At the next visit the patient was still unrelieved, pulse almost imperceptible, great thirst,

its odor. If the organic contents of the stomach be distilled, the distillate then shaken with ether and evaporated, the oil will be separated. This may be recognized by its odor. When heated with iodine, it detonates and gives off yellow or violet-red fumes. When distilled with water and sodium chloride, it effervesces, giving off carbon dioxide, and yields chloroform.

Illustrative Case of Savine Poisoning.—Letheby (*Lancet*, London, i. 677) reports a case of poisoning by savine. A woman, aged twenty-one, had enjoyed remarkably good health up to twelve hours before her death. On the night of April 22 she supped with her lover, at which time she was cheerful and hearty, but about 3 o'clock in the morning she complained of a pain in her stomach. She was very sick and her mother gave her some brandy and water. The sickness, however, was not diminished, and she subsequently became insensible. When seen by a physician at 11 o'clock she was lying on her back perfectly insensible, breathing laboriously and with stertor; she was foaming at the mouth, her countenance turgid; eyes closed, pupils much contracted; her limbs were also convulsed, and her mother told the physician that she thought that her daughter had been suddenly taken in labor. An examination was made per vaginam, and it was found that the os uteri was only slightly dilated; the membranes were ruptured and the uterus was acting vigorously, each contraction being accompanied by a convulsive tremor. As the os uteri became more fully dilated it was found that the head presented and was gradually descending. About 3 o'clock, while labor was thus progressing, she uttered a low moan and in a few minutes expired. Deceased was between the seventh and the eighth months of pregnancy.

Postmortem Examination (*twenty-four hours after death*).—Body bore no marks of violence. On opening the head the vessels upon the surface of the brain were found to be much gorged with black fluid blood; the gray matter was infiltrated in various parts by the same dark-looking blood, more especially noticeable in the anterior part of the corpus striatum. Choroid plexus was also gorged; ventricles empty.

an acrid principle, which, according to Guibourt, was found to pervade the whole kernel in connection with the oil; the symptoms presented are very similar to those of cholera, there being pain, vomiting and purging, with great prostration.

Dose.—One or two of the seeds when taken internally have a powerful cathartic action and often cause emesis. Three seeds have been sufficient to cause death in an adult after forty-six hours from the time of their taking, and in another case of a young woman 20 seeds resulted in death in five days.

Illustrative Case of Castor Oil Poisoning.—Meldrum (*British Medical Journal*, London, 1900, i. 317) reports a case of poisoning by castor oil seeds. Man, aged twenty-six, in good health, ate on January 23 a couple of castor oil seeds. That evening he complained of griping pains in the abdomen, and vomiting and purging followed. He was not seen by a physician until the morning of the 26th. At this time he was in a state of great agony and restlessness; tenderness and pain in the epigastric and umbilical regions were especially marked. There were incessant vomiting and purging; extremities were cold, brow bathed with perspiration; pulse weak, very compressible but regular. The stools and vomitus were watery, sanguineous, and slimy. Portions of the shell of the seeds were found in the vomitus. Under treatment the purging stopped, but the vomiting persisted, and he died on the 29th from exhaustion.

Postmortem Examination (*January 30*).—Head: meninges and brain congested, and there were numerous petechiæ. Thorax: lungs congested, no pleuritic effusion. Heart pale, its cavities containing clots. There was a fair amount of effusion in the pericardial sac. Abdomen: the general peritoneum was healthy, no effusion. Stomach was highly congested; contents watery and sanguineous. The mucous coat was much attenuated, with a scattering of erosions, with a pale grayish base. Intestines: contents watery, slimy and sanguineous, not very fetid. Small intestine was extremely congested, with great attenuation of the mucous coat. Duodenum and cæcum were less affected, the large intestine least of all. Kidneys and other viscera were congested.

Dose.—A ½ drachm of the aqueous extract has killed an adult within eight hours.

Postmortem Appearances.—The postmortem appearances simulate those of any of the neurotic irritants, inflammation of the intestine being especially well marked, and congestion of the brain and various organs present.

GREEN HELLEBORE.

Green Hellebore (Veratrum Viride, American Poke, Indian Poke) is found more or less generally distributed through the middle United States as far south as the Carolinas, but more common in the northern districts. It usually occurs in swamps, wet meadows, and along mountain streams. Its activity depends upon the presence of two alkaloids, *Veratroidine* and *Jervine*, to which its effects are largely due.

It is sometimes used in medicine as a cardiac depressant, usually in the form of a tincture. When taken in medicinal doses, it reduces the body temperature, without much lessening the heart-beat, and after a time the pulse-rate falls. Poisonous effects have followed in many cases from incautious use of the drug.

Symptoms.—The symptoms presented in poisoning by this means are those of a gastroïntestinal irritant, modified by its depressant action upon the heart. The heart may be in the early stages slow, but is always soft; later it is rapid, running, and almost imperceptible. Nausea, vomiting, and great muscular weakness are also present.

Treatment.—The stomach should be emptied, absolute rest insisted upon, opium and cardiac stimulants given, and external heat applied.

WHITE HELLEBORE.

White Hellebore (Veratrum Album, Veratrine) is the most poisonous of the hellebores. It closely resembles veratrum viride both in appearance and characteristics. It is a native of continental Europe and most common in the mountainous

and intestines is the most characteristic. The brain and kidneys are usually congested. In some instances, however, in which death apparently results from its neurotic rather than its irritant effects, marked congestion of the brain, with normal stomach and intestines, has been found.

Tests.—Colchicine, the active principle, occurs as fine white crystals with a slight alkaline reaction, soluble in water, and with a bitter, acrid taste. The best test is probably the nitric acid one, which produces a violet color changing to blue and brown. It differs from veratrin, which it resembles in other particulars, in that sulphuric acid has no effect.

Illustrative Case of Colchicum Poisoning.—Moyer (*Medical News*, Philadelphia, 1894, lxiv. 457) reports a case of colchicum poisoning. Between 4 and 5 P. M., on September 10, a physician administered an unknown quantity of colchicum to a woman twenty-two years of age. She was apparently in good health, with the exception of chronic constipation, for which the drug was administered. She reached home about 5 P. M., somewhat overheated from walking rapidly. She immediately took a cold bath and changed her clothing. About 7 P. M. she had a severe chill, followed by vomiting and frequent movements of the bowels, with very severe colicky pains in the abdomen. This condition continued until 10.30 P. M., when a physician was called, who administered sedatives. Very early the following morning the pain subsided, the vomiting ceased, and she became quite comfortable. Her condition remained about the same until about 12 M. the following day, when the pulse and respiration began to fail. Stimulants were administered, and she then remained about the same until 12 o'clock the following night, when another sinking spell came on. Stimulation was of no avail, and the respiration and pulse continued to fail, and death took place at 4 A. M., thirty-six hours after taking the poison.

Postmortem Examination (*ten hours after death*).—Head: dura normal. Superior longitudinal sinus contained a long, slender goose-fat clot. Pia normal. Basilar artery and anterior communicating artery each contained a minute whit-

decoction to a half-liter; and then drank a glassful. Forty-five minutes later symptoms of poisoning set in strongly. Believing the pains to be due to the beneficial action of the compound, he drank a second glass. The symptoms grew worse; vomiting, delirium; most violent contortions accompanied by extreme coldness, which nothing could overcome; and death took place one hour and a quarter after taking the poison.

Postmortem Examination (*sixteen hours after death*).—Lungs were engorged; mucous membrane of the stomach was considerably inflamed, blackish brown in color and almost gangrenous. Œsophagus and intestines showed no change.

GELSEMIUM (YELLOW JASMINE).

Gelsemium is obtained from the roots of *Gelsemium Sempervirens*, which is a plant growing along the seacoast from Virginia to the extreme south of Florida. All portions of the plant are said to be poisonous, but the root is the part most commonly used. Its poisonous effect is due to the alkaloid *Jasmine* and *Gelseminic Acid*. It is usually prescribed in the form of a tincture. It has been used in a great variety of diseases as a sedative and cardiac depressant, and is also said to have antiperiodic properties.

Symptoms.—In small doses in a healthy adult it produces agreeable sensations of languor with muscular relaxation. Larger doses cause dimness of vision, dilated pupils, dizziness, great muscular weakness, incoördination, ptosis, weak pulse, and occasionally spasms of the larynx. Respiration is slowed and weakened. This condition is usually followed by profuse sweating, although in one or two cases which have been reported the skin was dry. The mind is generally clear up to death, which usually occurs as the result of failure of respiration.

Dose.—A child of three years was killed by 12 drops of the fluid extract; ½ drachm of the tincture has caused death in less than two hours. Death is commonly rapid.

Postmortem Appearances.—The postmortem appearances are

Properties.—The tips and leaves have a strong, heavy, disagreeable odor, and a bitter, acrid taste, this being less noticeable in the dried than in the fresh state. Its properties, together with its medicinal action, are due to the presence of a volatile oil called *Oleum Sabinæ*. This oil is described as nearly colorless or yellow, limpid, strongly odorous, and of a bitter, extremely acrid taste, with a neutral reaction and specific gravity 0.910. It is soluble in an equal weight of alcohol.

When the oil or powder of the tops is used for medicine externally, it acts as an irritant; and when taken internally in toxic doses, it produces great weakness, convulsions, unconsciousness, and hemorrhages from the kidneys and uterus. It is rarely used in homicidal or suicidal poisonings, but is not infrequently, especially in Europe, taken for the purpose of inducing abortion.

Symptoms.—The symptoms presented by toxic doses of savine are those of the strong neurotic irritants: vomiting, diarrhœa, stools possibly mixed with blood; a weak rapid pulse; cold, moist skin; convulsions, delirium, unconsciousness; hemorrhages from the uterus and kidneys; suppression of urine and possible abortion.

Dose.—Death has resulted from the taking of 1 drachm of the oil, and serious symptoms from a less quantity. When applied locally, as in the treatment of skin diseases, one case has been reported in which symptoms of irritation followed the repeated application of an ointment containing 2 drachms to the ounce. Death has resulted within twelve to eighteen hours after the taking of a dose, or it has been delayed for several days.

Postmortem Appearances.—The most characteristic conditions found are those of gastrointestinal irritation combined with marked congestion of the capillary system, both in the abdominal organs and brain. The blood is usually very dark-colored.

Tests.—When powdered savine has been taken, the color of the stomach contents will usually be greenish, and the structure of the herb may be recognized under the microscope. If the oil has been taken, a suggestion of its presence will be

Postmortem Examination (*five and a half hours after death*).—Rigor mortis marked. The blood was very fluid and dark colored, and showed no tendency to coagulate or to turn red upon exposure to the air, even after standing in a large tub for over two hours. Heart, lungs, spleen, and kidneys normal. Liver dark colored and contained much fluid blood. Stomach contained four ounces of light-colored fluid mixed with glairy mucus. Its internal surface was deeply congested and marked by tortuous dilated vessels. Intestines normal. The internal substance of the cerebral lobes was dotted here and there with small red points, but these were not sufficiently large or numerous to be considered of much pathologic importance. No collection of fluid in the ventricles.

POISONOUS MUSHROOMS.

Much uncertainty exists in the minds of those who have made a study of the subject in regard to the poisonous action of the fungi, and during the past many divergent opinions have been expressed. It is, however, well known at this time that these differences of opinion have depended upon the fact that individuals vary much in the effect upon them resulting from the eating of fungi. It is evident that some of the so-called mushrooms are edible, nourishing, and to a majority of persons entirely safe forms of food. There are other varieties which are extremely poisonous. The third class are those which are poisonous under certain conditions and bland under others, or poisonous to some individuals and not poisonous to others. In addition, there are a number of individuals who, on account of personal idiosyncrasy, are unable to eat fungi of any variety without more or less serious symptoms, and it should also be remembered that partially decayed fungi of any variety are more or less poisonous.

From certain of the fungi a poisonous principle has been isolated in the form of *Muscarine*. Muscarine is the poisonous principle of *Agaric* or *Boletus Genus*, and a second alkaloid, *Amanitine*, has been isolated. The active principles of the majority of other poisonous mushrooms have not been

Lungs were a little congested in the dependent parts, but otherwise healthy. Heart not examined. Stomach on being opened appeared rather paler than usual, with the exception of one or two spots, which were red, as if blood had been effused into the mucous tissue. It contained about four ounces of a dark brownish-green fluid, which smelt strongly of digesting matter and had an acid reaction. Oil of savine was obtained from this fluid by distillation. The other abdominal viscera were not examined.

HELLEBORE.

The term hellebore is applied to three forms of poison, the black, white, and the green; more strictly speaking, it applies to the black hellebore, *Helleborus Niger;* the term white hellebore is applied to *Veratrum album*, and the term green hellebore to *Veratrum viride.*

Black hellebore is obtained from the roots of *Helleborus Niger,* which is a native of temperate Europe, and found especially in Greece, Austria, Italy, Switzerland, France, and Spain. It is cultivated in gardens on account of the beauty of its flowers, which, opening in the middle of winter, have given to it the name of Christmas rose.

Action.—The black hellebore is a violent hydragogue cathartic, supposed by some to have a specific action upon the uterus. In overdoses it acts as a violent gastroïntestinal and neurotic irritant. It was formerly used and strongly recommended in the treatment of amenorrhœa, dropsy, and various forms of mental and nervous diseases. It has also been used for certain skin diseases.

Symptoms.—When taken internally, especially in the form of decoction or infusion, whether of the roots or leaves, it is followed by the symptoms of a gastroïntestinal, neurotic poison: vomiting, violent catharsis, severe abdominal pain, prostration, convulsions, insensibility, and death. When applied externally, it has an irritant action. It has been used by charlatans largely in the treatment of worms, and as such is frequently taken in overdose.

to recognize in the contents of the stomach spores or other fragments of the fungi.

Illustrative Case of Poisoning by Mushrooms.—Handford (*Lancet*, London, 1886, ii. 1018) reports a case of mushroom poisoning with a fatal result. Man, aged thirty-two, gathered about a quarter of a pound of what proved to be *Agaricus (Amanita) phalloides* (Fries) on the afternoon of August 20. He fried them in fat, and ate them about half an hour after his regular tea at 7.30 P. M. He went to bed at 10 P. M. and slept well all night. He got up at 5 A. M. and complained of a weight and sense of constriction about the chest; he had pain in the bowels and passed an ordinary motion. He went to work at 6 A. M., and between then and 8.30 vomited three times. At first he brought up the mushrooms very little altered, and afterward a yellowish mucous fluid. He was purged several times and sweating was profuse. Sight was not affected. He worked until 11 A. M.; the vomiting and purging had continued and he felt weak and faint, but was able to walk home after taking some brandy. Sweating continued, his sight became dim during the afternoon, and he was admitted to the hospital about 8 P. M., August 21. On admission he complained of pain in the abdomen, pulse was very small, and he was in a condition of collapse. An emetic was administered and he vomited freely. He passed a restless night, vomiting and purging continuously. When seen at 11 A. M., August 22, he was extremely exhausted, voice husky. Pupils equal, of normal size and reacted to both light and accommodation. Skin moist but sweating had ceased. Pulse was only just perceptible at the wrist and could not be counted. Heart-beats were weak, regular, 92 per minute; respiration 17 per minute, and sighing. Temperature 97° F. He complained of much pain in the abdomen, especially in the left lumbar region, which was tender on pressure. Atropine was given hypodermatically, after which his condition was somewhat improved. At 8 P. M. he was restless and slightly delirious. Diarrhœa and vomiting still persisted. Pupils slightly dilated, but reacted to light. Urine suppressed. Pulse very small and wiry, 128 per

regions. All parts of the plant are said to be poisonous, but the drug is usually obtained from the roots.

Action.—White hellebore is an active emetic and cathartic, and even when applied externally to denuded surfaces, such as ulcers, absorption is followed by violent abdominal pain, emesis, and catharsis. When snuffed into the nostrils, it is a strong irritant and excites violent sneezing, sometimes to a dangerous extent. White hellebore owes its active qualities to the alkaloid *Veratrine* which it contains.

Symptoms.—When taken internally, either in the form of tincture, powder, or infusion, in poisonous doses, there are dryness, heat, and constriction of the throat, nausea, vomiting, diarrhœa, great prostration, feeble pulse, dilatation of the pupils, giddiness, convulsions, insensibility, and probably death.

Dose.—Taylor quotes a case in which $\frac{1}{16}$ grain of veratrine resulted in alarming symptoms. Ordinarily from $\frac{1}{4}$ to $\frac{1}{2}$ grain will give toxic symptoms, and doses much larger than this are apt to be fatal. Death usually results in from sixteen to eighteen hours.

Tests.—White hellebore is obtained from the shops usually in the form of a whitish powder, almost insoluble in water, but soluble in alcohol, ether, and benzine. This powder has a strong, hot, acrid taste. Nitric acid turns the powder a light red. When hydrochloric acid is added and heat applied, a darker red is obtained. When sulphuric acid and heat are applied, they create a rich pink color, which is destroyed by chlorine. Veratrine is insoluble in water, but soluble in a dilute solution of acetic acid. It is turned yellow changing to a crimson by the addition of sulphuric acid and mild heat. Strong hydrochloric acid and heat give a color resembling a strong solution of potassium permanganate.

Illustrative Case of Hellebore Poisoning.—Chevallier (*Annales d'Hygiène publique*, Paris, 1877, 2.s., xlviii. 465) reports a case of poisoning by hellebore. A servant who had been ill for two or three months consulted a quack, who gave him root of Solomon's seal, leaves of ground ivy, and root of black hellebore. He boiled these in cider, and reduced the

some fluid consisting of mucus and milk. Brain was not examined.

QUESTIONS.

Describe poisoning by oxalic acid.
By tartaric acid.
By carbolic acid.
By croton oil.
By elaterium.
By castor oil.
By colchicum.
By savine.
By hellebore.
By green hellebore.
By white hellebore.
By gelsemium.
By poisonous mushrooms.

CHAPTER VII.

ANIMAL IRRITANTS.

CANTHARIDES (SPANISH FLIES).

THE term cantharides has been applied in a very general way to many classes of *Coleopterous* insects or beetles. Linnæus gave this title to a genus not including the insect to which we apply this term. The term now, however, is applied to *Cantharis vesicatoria*, a small beetle, six to ten lines in length by two or three in breadth, and of a shining golden-green color, which abounds in Spain, Italy, and the south of France, and is also found in the temperate portions of Europe and Asia. In the United States there are other members of the same family which have been used as substitutes for the officinal one with very satisfactory results.

Properties.—The powder is grayish brown and contains green shining particles; odor strong and disagreeable. It has an acrid, burning, and urinous taste. If kept perfectly dry, it retains its activity for a long time, but when exposed to damp air undergoes putrefaction and loses its vesicating power. A volatile active principle has been isolated, which acts in the same way upon the system as does the powder, and is called *Cantharidin*. This is described as

not at all characteristic. Congestion of the superficial veins is perhaps the most constant condition found. Irritation of the gastroïntestinal tract and congestion of the organs are common.

Tests.—Sulphuric acid when applied to a pure solution at first has no effect. If, however, it is not pure, the color is at first brownish and then changes to a purple. If to the acid solution of gelsemium a small fragment of potassium bichromate is added, a red color is first produced soon changing to a blue.

Illustrative Case of Gelsemium Poisoning.—Boutelle (*Boston Medical and Surgical Journal*, 1874, xci. 321) reports a case of fatal poisoning by an overdose of gelsemium sempervirens. Male, aged twenty-four, suffered from pains of a neuralgic character from which he could not get relief. There happened to be a vial of extract of gelsemium (Tilden's) in the house, from which he took a teaspoonful at 1 A. M., and in about fifteen minutes repeated the dose. The pain was soon relieved, and his eyes felt heavy, but in about half an hour he began to complain of choking, and soon arose struggling for breath, pushing his fingers into his throat as if trying to tear it open. He staggered from one room to another as though intoxicated, and in a short time after these symptoms came on he threw himself upon the floor and became unconscious. When seen at 4 A. M. he was moribund, respiration gasping, 3 or 4 per minute, pulse rapid and feeble. He was totally unconscious and could not be aroused; pupils dilated, not responsive to light, and could be touched without causing contraction of the lids. Muscles relaxed, lower jaw drooping. Skin moist, extremities cold. Cold water was applied to the face and chest; brandy and water in small quantities was given frequently, and five grains of ammonium carbonate every five minutes. Mustard to spine and friction to lower extremities. Respiration became more infrequent and the pulse grew slower and weaker. Artificial respiration was kept up for half an hour without avail, and he died at 4.45 A. M. No convulsions at any time.

mation of the alimentary canal, of the kidneys, uterus, and bladder, and internal organs of generation, will be found. If the dry powder has been taken, the peculiar shining particles of the insect may be recognized in the stomach and intestines. Congestion of the brain is usually present. Taylor reports a case in which 1 ounce of the tincture was taken and death did not occur for fourteen days. In this case there was no inflammation of the mucous membranes noted, but in the stomach the membrane was pulpy and easily detached. There was, however, much inflammation of the kidneys.

Tests.—When the powder has been taken, it is usually comparatively easy to detect portions of the insect in the contents of the stomach and intestine, even with the naked eye. When the tincture or the active principle cantharidin is the cause of death, the active principle itself must be isolated. This is done by evaporating the contents of the stomach and intestine to dryness and digesting the remainder with ether, which dissolves out the cantharidin. This solution is evaporated to an extract. If a portion of this extract containing cantharidin be spread on oiled silk and placed in contact with the lips or a delicate skin, vesication will result, and will prove the presence of cantharidin.

Illustrative Case of Cantharides Poisoning.—Tardieu (*Étude sur l'Empoisonnement*, Paris, 1875, p. 1223) relates a case of suicidal poisoning by cantharides. Male, aged forty, insane for two years, and suffering from general paralysis and trembling, swallowed at 7.30 A. M. 15 grammes of dough containing 8 grammes of powdered cantharides. Fifteen minutes later an emetic was administered, which was followed by repeated copious vomiting. The vomitus was of a mucoserous character and contained such large quantities of cantharides that it was supposed that none could have remained in the stomach. Toward 10 A. M. small blisters formed on the lips; and the mucous membrane of the mouth was intensely red. After vomiting the body temperature was less. Toward 5 P. M. slight fever set in; temperature and pulse increased. This condition lasted twelve hours, when it began to diminish steadily. Ten hours after taking the poison there

isolated, but enough is known about them to warrant an opinion that they vary much in form and activity. The fact that boiling renders some of the otherwise poisonous mushrooms innocuous justifies the belief that, at least in certain instances, the active principle is a volatile one. Immense quantities of mushrooms are grown for the table, especially in Europe, and they are, under proper conditions, a very valuable form of food.

Symptoms.—In a general way the action of poisonous fungi of all kinds is similar to that of the narcotic irritants, the symptoms usually presenting themselves within an hour after their taking. The first are vomiting, purging, abdominal pain, thirst, dilated pupils, dimness of vision, delirium, and if the progress be toward a fatal termination, narcotic symptoms appear, and we have coma, convulsions, death. When after severe poisoning the termination is a favorable one, the symptoms do not entirely disappear until the lapse of several days and in some cases weeks. The onset of the symptoms varies, and while in the acute form narcotic effects come on rapidly; in certain cases the symptoms are delayed for a considerable number of hours, coming on after the lapse of twelve to twenty-four. In some cases the irritant effects are the most marked.

Postmortem Appearances.—The pathologic results of mushroom-poisoning have not been well described, and in reported cases there seems to be a very considerable variation. Usually the most marked are a more or less general lividity of the body, fluid blood, rapid decomposition, ecchymoses in the pleura, peritoneum, pericardium, etc., and violent and even gangrenous inflammation of the stomach and intestines. Congestion of the brain is common. Taylor reports a case which both in symptoms and postmortem appearances closely simulated arsenical poisoning.

Tests.—So far as is known, the one satisfactory demonstration which may be had of mushroom-poisoning is by microscopic examination of the contents of the stomach. When such an examination is made carefully it is usually possible

including fish, birds, or any such animal products as cheese, is associated with the formation of certain chemical compounds known as **ptomains.** These ptomaïns vary much in their effect, but many of them are extremely poisonous. Decomposed animal food always contains ptomaïns of some sort, and is therefore unfit for food. It is, however, a fact that people vary much in their susceptibility to ptomaïn-poisoning. Among the most common sources for such poisoning are sausages, cheese, putrid fish and meat.

Symptoms.—The symptoms of poisoning by products of decomposition are those of gastro-intestinal irritation, somewhat violent in character, and may simulate poisoning by some of the more common chemical irritants: nausea, vomiting, diarrhœa, abdominal pain, with or without fever, are the most common. The treatment consists in the evacuation of the stomach and intestines, the relief of pain, and stimulation.

Idiosyncrasy.—It is a well-recognized fact that some individuals are violently poisoned by foods of various kinds which under exactly similar circumstances do not affect unpleasantly the vast majority of people. This is especially true of a variety of shell-fish, such as mussels, oysters, and lobsters. It is equally true of certain vegetables and certain fruits, and to a somewhat less extent of more common articles of animal food, such as mutton, pork, or sausages.

Symptoms.—The symptoms which present themselves in these cases of idiosyncrasy vary over wide limits with different individuals. The symptoms which follow the taking of the same food by different individuals, all of whom are poisoned by it, will vary from a slight headache or eruption on the skin to the most violent forms of irritant poison. They are usually of the same type in the same individual on different occasions.

Illustrative Cases of Poisoning by Decomposed Foods.—Mitchell (*Medicine*, Detroit, 1895, i. 351) reports two fatal cases of sausage poisoning. Delia C., aged five, and Herbert C., aged three, with two other children, bought a quarter of a pound of Frankfort sausages, which they ate uncooked.

minute. Catheter was passed at 9.30 P. M., but there was no urine in the bladder. Patient passed a very restless night. At 10 A. M., August 23, temperature subnormal; pupils not dilated; tongue moist and coated with a thin yellowish fur. Vomiting had ceased and urine was still suppressed. Abdomen retracted, and pain in the bowels was extreme; tenderness in both lumbar regions. Pulse could not be counted at the wrist at all; heart-beats 120; respiration sighing. He died at 4 P. M., about sixty-eight hours after eating the mushrooms.

Postmortem Examination (*twenty-two and a half hours after death*).—Rigor mortis well marked. Punctiform ecchymoses on the surface of the left lung, scattered about under the visceral pleura, and grouped together in large numbers where external support was least, especially along the margins of the base. Lung-substance congested, but crepitant. Right lung so adherent as only to be removed piecemeal; base and posterior part of upper and middle lobes in a condition of hypostatic pneumonia. Punctiform ecchymoses numerous under the visceral pericardium, especially along the interventricular septum and at the roots of the large vessels. Heart: muscular substance pale; left ventricle firmly contracted and empty; right contained a small quantity of recent black clot; valves healthy; abundant postmortem staining. Liver was in an advanced condition of fatty infiltration. Kidneys pale and anæmic, capsule easily stripped. Bladder contained scarcely half a drachm of urine. Stomach contained about three ounces of milk curd and brown-colored fluid. The mucous membrane was covered with tenacious mucus and was much congested. There were numerous points of capillary hemorrhage, and at the cardiac end numerous superficial excoriations about the size of a millet-seed. The whole of the small intestine was slightly congested, and this condition was very marked in the lower two feet of the ileum, where the solitary glands were very conspicuous and stood out prominently. The contents of the small intestine were chiefly mucus and intestinal fluid with a little curdled milk. The large intestine contained

proceeded so far, pieces of sausage being distinguishable in the stomach contents. On examining the sausage, the links appeared shrunken, had a stale, musty odor, and were covered with clammy moisture. On cutting them open, nothing special was noticed except that the stale odor was more pronounced. There was no difference in color between the outer part and the centre. Chemical examination of the stomach contents and sausage resulted in the production of extracts which gave symptoms of poisoning when injected into cats.

POISONED FOODS.

Animal food not very infrequently results in severe poisonings, although the food in itself be perfectly fresh, and so far as can be detected in an entirely edible condition. Such symptoms may be due to the fact that birds, animals, or fish have been killed by poison or have been fed upon some substance innocuous to them but poisonous to the human being. As an example of this latter condition furnished by Reese, certain birds, like the pheasant and grouse, are in the habit of feeding upon leaves and buds of *Kalmia* (Laurel). This plant, while not poisonous to these birds, is poisonous to the human being, and the flesh of birds under these conditions has given rise to violent poisoning in those who have eaten them. Reese also states the fact that the milk of cows and goats which have fed upon *Datura Stramonium* may prove poisonous to those partaking of it. The flesh of animals, birds, or fish killed by the taking of arsenic, strychnine, or similar poison, when eaten may result in poisoning and give rise to symptoms dependent upon the action of the drug which was taken.

TRICHINA SPIRALIS.

Trichinosis is, so far as we know, always a fatal condition, due to the introduction into the blood of *Trichina spiralis*. The symptoms produced by it in certain cases closely resemble those given by acute poisoning, and several authors have referred to the possibility of mistakes arising, stating that

a white substance in the form of crystalline scales of a shining, micaceous appearance; odorless, tasteless, almost insoluble in water and alcohol, soluble in ether, chloroform, benzol, and oils. It is volatilized by heat without decomposition, and its vapor condenses in acicular prisms. Cantharidin has been found to combine as an acid with the alkaline bases, forming soluble compounds with potassium, sodium, and lithium hydroxides, also slightly soluble compounds with barium, strontium, and calcium hydroxides. The decoction and tincture of cantharidin have the same medicinal action as does the powder.

Cantharides is **largely used in medicine**, externally as a blister or counterirritant, and when given internally acts as a powerful irritant with a special effect upon the urinary and genital organs. When the dose is a small one, it sometimes acts as a diuretic, and is generally associated with considerable irritation of the urinary passages.

Symptoms.—When given in poisonous doses, it acts as a violent irritant to the gastro-intestinal and genito-urinary organs associated with vomiting and purging, abdominal and lumbar pain, and great thirst, the vomitus being frequently mixed with blood or shredded mucous membrane. There is more or less difficulty in swallowing. There is usually considerable desire for urination and the passing of small quantities of bloody urine associated with tenesmus. Priapism occurs in males and swelling of the labia in females. These symptoms are followed by convulsions and death.

Dose.—1 ounce of the tincture and 24 grains of the powder have caused death in periods varying from twenty-four to thirty-six hours. $\frac{1}{100}$ grain of cantharidin has caused local irritation and constitutional symptoms of considerable severity.

Treatment.—There is no known antidote. The treatment consists in early and rapid emesis and catharsis, with opiates to control pain, and stimulation.

Postmortem Appearances.—Where death has occurred within a comparatively short time and the poison has been taken either in the powder or concentrated solution, violent inflam-

cure; neither is there any treatment except the preventive of thoroughly cooking the meat which may contain these parasites. Smoking and curing in the various saline solutions or partial cooking are not sufficient to destroy the parasite in its chrysalis.

Illustrative Case of Trichina Spiralis Poisoning.—Jump (*Pacific Medical and Surgical Journal*, San Francisco, 1891, xxxiv. 216) reports a fatal case of trichinosis. The patient, an Italian, aged twenty-two, slaughtered a sow on December 24, which had been kept in a close pen for two months. On the 28th he ate some of the raw pork—tenderloin. No complaint was made until January 2, when he complained of nausea and stopped work. On the evening of the 5th he vomited three or four worms four or five inches long and slender (*Oxyuris vermicularis* probably). He was constipated and had some fever. He called in an irregular physician on the 10th, who treated the case for ten days, for which time no history could be obtained. When seen by Jump on January 20, at 10 A. M., he found him lying on his back in a profuse perspiration, anxious countenance, cough with reddish-brown expectoration, feet and legs slightly swollen, œdematous along the tibia, muscles extremely sore with rheumatoid pains. He could hardly stand and could not walk a step alone. Constipation with slight tympanites. Tongue coated a good deal like that in typhoid fever, with red margin, but no sordes. Temperature in axilla 102° F.; pulse 112. Intolerable thirst. Small red spots on abdomen. Complained of soreness about diaphragm, so that he could not cough without pain. He had not slept for more than fifteen minutes at a time for weeks. January 20, 7 P. M., the bowels had moved twice, and the discharge was extremely offensive. Temperature 103.5° F.; pulse 120. Sulphate of morphine and atropine were ordered, and he rested and slept pretty well during the night. January 21, 8 A. M., temperature 102°; pulse 112; skin moist. Quinine was given, which was followed by profuse sweating. Bowels moved four times during the day. Cough and expectoration remained about the same. January 22, 8 A. M., temperature 101°; pulse 108. Profuse

was considerable meteorism. The penis, especially the glans, was livid; no erection. After the fever subsided the limbs became somewhat rigid, and the intellect became more benumbed than before. Stupor and dyspnœa appeared; the patient continued in this state until 8.30 A. M., when he died, twenty-five hours after taking the poison.

Postmortem Examination.—Skull thin; bloody serum between dura mater and arachnoid. Vessels of the meninges (particularly the venous) filled with blood. Arachnoid and pia mater inflamed and thickened throughout. Considerable serum in the convolutions and lateral ventricles. White and gray substance softened. Heart and lungs normal. Stomach contained part of the drinks administered during life. Mucous membrane dotted throughout with red; here and there ecchymoses were found, mostly near the pylorus and cardiac orifice; at these places a few particles of cantharides were also found. Small intestine distended by gas; otherwise normal; no fluid contents. Large intestine normal. Liver enlarged. Left kidney contracted, red and congested; right kidney normal. Left ureter reddish internally; right normal. Bladder very much thickened, compact and resisting; mucous membrane red and injected.

QUESTIONS.

Describe poisoning by cantharides.

CHAPTER VIII.

POISONOUS FOODS.

VARIOUS forms of animal food in varying conditions may give rise to symptoms of acute poisoning and even death. These effects usually depend upon one of three causes.

DECOMPOSED FOODS.

The process of decomposition and fermentation occurring in any form of animal food whether cooked or uncooked,

CHAPTER IX.

CEREBRAL NEUROTICS.

NARCOTICS.

Under this head are included those forms of poison whose symptoms are the result of the physiologic action of poisons upon the brain.

The symptoms of this class of poisons are largely drowsiness, headache, dizziness, delirium, convulsions, paralysis, and coma. As a rule signs of irritation of the gastrointestinal tract are wanting.

The appearances found on **postmortem examination** are usually insufficient to base a diagnosis upon. All signs may be wanting, and if any are present they are usually limited to a certain amount of congestion of the vessels of the brain, frequently associated with effusions of serum, and rarely with effusions of blood into the membranes overlying the brain.

OPIUM.

Most of the opium of commerce is manufactured from *Papaver Somniferum*, found wild, and also under cultivation, in large amounts, in India and other portions of southeast Asia. It may, however, be cultivated in southern and temperate Europe and America. All portions of the poppy contain opium; in the leaves, however, there is a very small amount. In the capsule there is found the largest quantity, and it is from this portion of the plant that most of the drug is manufactured.

Properties.—When expressed from the plant, it is a milky exudate, and in commerce it appears as a solid. Good opium has a peculiar, strong odor, and a bitter, somewhat acrid taste, and is of a reddish-brown or deep fawn color. When soft, as it is when not exposed to the air, it is tenacious,

This was at 11 A. M. At 1 P. M. they ate their lunch, which consisted of bread and butter and cooked Frankforts (from the same shop at which the quarter of a pound had been purchased). No unusual taste was detected in the sausages at lunch, but within half an hour the mother and five children were suddenly taken sick with pains in the stomach and bowels, and vomiting. The eldest child, a girl of fourteen, had an attack of vertigo and fell to the ground. By this time the mother's attention was attracted to the two small children, who were unconscious, and "blue in the face"; these of all the family had not vomited. When seen by a physician at 3.45, both children were cyanotic and moribund. Herbert had no pulse at the wrist, and that of Delia was scarcely perceptible. All efforts were fruitless; Herbert died immediately after the arrival of the physician, and Delia five minutes later. The others recovered in a short time without treatment, though a boy of eight had abdominal pains and nausea all night.

Postmortem Examination (*seventeen hours after death*).—Body of Delia was well nourished. Rigor mortis but slightly developed; cadaveric lividity in a moderate degree on dependent portions. No evidences of decomposition. Pupils dilated equally. Abdomen not retracted. Pericardium contained two drachms of straw-colored fluid. Heart normal and perfectly empty. Trachea was filled with a frothy fluid, and the lining membrane congested. Pleura free and empty; lungs congested and œdematous throughout, with patches of marginal emphysema, and areas under the visceral pleura containing air, mostly on the left side. Stomach contained a grumous mass smelling like sausage, and was markedly congested, especially at the pylorus. Small intestine in its upper part was much congested; duodenum deep crimson in color, the tint growing lighter gradually until the normal color of the mucous membrane was reached about the middle of the jejunum. The solid abdominal viscera were full of dark blood, and negative. Bladder empty. The appearances in the case of the little boy were precisely the same save that there was not so much emphysema, and digestion had not

action is very much alike. Cases of suicidal and homicidal poisoning by the use of opium or morphine are extremely common, and accidental cases from the taking of an overdose are also common. Accidental poisonings from its use in patent medicines are very common, especially among infants. The majority of the soothing cough mixtures and sedatives contain opium or morphine in large amounts.

Symptoms.—The symptoms of poisoning by opium and morphine are essentially the same, morphine acting more rapidly than opium, and the rapidity with which opium acts will depend upon which of its many medicinal forms is taken. Taylor describes the symptoms as follows: "A condition of pleasurable mental excitement, usually of very short duration, is experienced; but this is followed by weariness, headache, incapacity for exertion and sense of weight in the limbs; diminution of sensibility, giddiness, drowsiness, and strong tendency to sleep; stupor succeeded by perfect insensibility, the person lying motionless with the eyes closed as if in a sound sleep. In this state he may be easily roused by a loud noise and made to answer a question, but he speedily relapses into stupor. In a later stage, when coma has supervened with stertorous breathing, it will be difficult, if not impossible, to arouse him. The pulse is at first small and irregular, the respiration hurried, the skin warm and bathed in perspiration; but when the person becomes comatose the breathing is slow and stertorous and the pulse slow and full. The skin is occasionally cold and pallid, sometimes livid, the pupils are contracted; but in the later stages, when progressing to a fatal termination, they may be found dilating. The expression of the countenance is placid, pale, and ghastly. The eyes are heavy and the lips are livid." In some cases of opium-poisoning there is vomiting and in rare cases purging. Vomiting usually occurs in cases in which a large dose of the concentrated form is taken, but on account of the fact that the stomach under such conditions is usually relieved of a large portion of its contents the chances for recovery are very much improved. The symptoms of poisoning occur at varying intervals after the taking of the drug, depending upon

some of the so-called cases of acute irritant poisoning, in which it has been impossible to recover the poison, may have been due to this condition.

The **Trichina** is a small worm which exists coiled in a minute oval capsule, and is usually found in the midst of muscular fibre, where it can be seen as a small white speck with the naked eye. Under the microscope it can be easily detected. It spends most of its life in the form of a chrysalis, as has been described, in the muscle of some of the warm-blooded animals, but after its transfer into the stomach of other warm-blooded animals it finds the condition favorable for its further development and multiplication.

Its most common **habitat** is in pork, and it is from the source of improperly cooked pork that it is most dangerous to man. After having been taken into the human stomach and intestines its period of incubation is from six to eight days, and during that time it multiplies to a most incredible extent. Taylor quotes Keller as saying, "That in three to four days the females produce one hundred or more young, which begin on the sixth day to leave the parent animal, and he estimates that in a few days after the ingestion of one-half pound of meat the stomach and intestinal canal of a person may contain 30,000,000 of these minute parasites." When meat containing these worms is taken into the stomach, the worms leave their capsules, propagate, and produce young in these vast numbers, which migrate through the intestinal wall into the muscular tissues. During these periods of development and migration symptoms of acute intestinal irritation are produced, which closely simulate the effects of poisoning by gastro-intestinal irritants.

Symptoms.—In the first stage we have the symptoms of intestinal irritation combined with loss of appetite, malaise, pain, general weakness of the limbs, swelling of the joints and eyelids, fever, and wasting. Death usually results from paralysis and wasting of the muscular tissues combined with fever, and in many cases peritonitis. The fatal result usually follows within a month after ingestion of the food.

Treatment.—So far as we know at this time there is no

Treatment.—There is no one drug which is a complete antidote to opium- or morphine-poisoning. Atropine overcomes the respiratory depression perhaps better than any other. Black coffee is to a certain extent an antidote and frequently relieves very rapidly the symptoms in minor poisoning. Strychnine, brandy, and other stimulants should be administered to overcome the marked cardiac weakness which is present during the later stages. The stomach should be emptied at the earliest possible moment by means of washing and emesis, and it is apparently the fact that if the victim can be kept awake by means of exercise, flagellation, etc., he will be able to stand a much larger dose than if he is allowed to go to sleep.

Tests.—There is no known chemical test for opium as such, and there is no positive means of identifying it whether it be in solid or in liquid form except by its physical properties, such as color, odor, taste, and its effect upon the lower animals. There are, however, in all cases in opium two substances which may be detected upon chemical examination, one its most active and important alkaloid, morphine, and the other meconic acid. For the purposes of chemical examination, therefore, opium must be considered as an organic solid or liquid containing morphine and meconic acid, and the tests will be those for these two substances. It very frequently occurs that on account of vomiting or irrigation of the stomach it is impossible to detect opium in the bodies of those who have died from its effects, and it should be remembered that it is perfectly possible that death may occur in cases of poisoning by opium or its alkaloids without leaving behind in the organs a sufficient amount of the poison to be recognized chemically as the cause of death. It is sometimes possible when opium has been taken in the solid form, or morphine in the form of powder, to detect in the stomach solid portions of opium or crystals of morphine. This, however, can be true only in cases in which death has occurred soon after the taking of the drug, in which vomiting has not occurred, and in which the stomach has not been washed out. The contents of the stomach and the organs which are to be

sweating. Dulness over the superior lobes of both lungs. Cough slight with plum-juice expectoration. Urine normal. He remained in about the same condition until January 26. January 26, 9 A M., temperature 97°; pulse 112; profuse sweating, looked haggard, respiration shallow but not hurried, feet and legs more swollen, motionless. He died at 9.30 A. M.

Postmortem Examination (*five and one-half hours after death*).—Rigor mortis slight. External surface of intestines appeared healthy, but they were not opened. Kidneys and spleen normal. Liver much enlarged and gall-bladder greatly distended. Superior posterior portion of both lungs in a state of hepatization, more marked in the left. No adhesions. About six ounces of serous fluid in each thoracic cavity, and two ounces in the pericardium. Opened and excised a portion of the gastrocnemius. Blood followed freely, thin and serous. A specimen of the muscle pressed under the fingers, then scraped, and the scraping placed under the microscope without a cover, revealed living trichinæ in motion, coiling, and when coiled seemed to be contented. Specimens taken from the gastrocnemius, diaphragm, pectoralis major, lung, and liver, were put in cold water until the next morning, when the trichinæ showed life by coiling up.

QUESTIONS.

Describe poisoning by cantharides.
By poisonous foods.
Describe *Trichina spiralis* and its effect on the animal economy.

intent, but his life was saved by the use of the stomach-pump. After that he took opium six times for the purpose of self-destruction, but was saved each time in a similar manner.

Postmortem Examination (*fourteen hours after death*).—Brain: arachnoid was opaque and much thickened on the upper surface of the hemispheres and about the base of the brain, but in other parts was smooth and transparent. General congestion of the bloodvessels and one or two small extravasations on the surface of the hemispheres. Ventricles contained more than the normal amount of serum. Lungs distended with air and fluid; anterior portions of a pale rose color, crepitant, and partly collapsed; the remaining portions being gorged with air and blood. Surface of the most "pendent" portion was spotted with black ecchymoses about an eighth of an inch in depth. Trachea and bronchi were partially filled with a frothy mucous fluid deeply tinged with blood; their mucous membrane was much congested. Stomach: mucous membrane was generally congested, and of a blood-red color about the cardiac end, becoming paler and punctiform toward the pylorus. Contents consisted of about half a pint of fluid which exhaled the odor of opium. Mucous membrane at the commencement of the duodenum presented punctiform congestion, but this soon disappeared, and was missing on approaching the jejunum. Morphine was detected on analysis of the stomach contents.

Illustrative Case of Chronic Opium Poisoning.—Andrews (*American Journal Insanity*, Utica, 1872–73, xxix. 13) reports a case of excessive hypodermic use of morphine. Woman, aged thirty, single, no hereditary tendency to insanity; of a highly nervous and excitable organization; at times buoyant and lively, and then gloomy and depressed. At the age of twenty, in April, 1862, she was seized with a very severe pain in the head, which was of short duration, but during its continuance the patient was delirious. Attacks of the same nature occurred afterward at intervals of from one to three months. These attacks of delirium took place at the menstrual periods. In 1864 she had acute rheumatism,

but after exposure to the air it hardens, becomes brittle, blackened, and has a shining fracture. When pulverized, it appears as a yellowish-brown powder. It becomes adhesive when warm. Its active principles are soluble in water, alcohol, and dilute acids, and to all these solutions it gives a deep-brown color.

The action of opium depends upon a number of active principles which it contains. The most important of these and those which are best established are seventeen in number; viz., *Morphine, Narcotine, Codeine, Thebaine, Papaverine, Narceine, Hydrocotarine, Pseudomorphine, Protopine, Laudanine, Codamine, Rhocadine, Meconidine, Cryptopine, Laudanosine, Lanthopine*, and *Gnoscopine*. Others, like *Apomorphine*, may be produced artificially from those alkaloids existing in opium. At least two acids exist in combination in opium, *Meconic Acid*, $C_7H_4O_7$, and *Lactic Acid*, $C_3H_6O_3$.

For purposes of toxicology it is probably unnecessary to consider any number of these derivatives. The toxicologic action of opium largely depends upon the morphine which it contains, so that opium and morphine will be considered together.

Morphine, when pure, has the following properties: it crystallizes from alcohol in the form of small colorless, shining, prismatic crystals, permanent in the air, odorless, having a bitter taste and an alkaline reaction, slightly soluble in water, more so in alcohol, and very slightly soluble in chloroform and ether. When heated on platinum, it fuses, then chars, and is finally completely dissipated. The three most important salts of morphine are the acetate, sulphate, and hydrochlorate. They are all soluble in water and alcohol and insoluble in ether. Both morphine and its salts are soluble in gastric juice.

Opium and morphine are used and have been used for many years in medicine.

Their action in small doses is somewhat stimulating; in larger ones decidedly narcotic. The action of morphine differs from that of opium in that it is less diaphoretic and less constipating and about six times as active. Otherwise their

while rubbing her breast. This was cut down upon and a broken needle extracted. On the 15th and 28th other needles were removed. On the 29th menstruation began again. Flow was profuse, and she became at once delirious. Was talkative, profane, obscene, and pulled her hair out. She continued in this condition some twelve hours, and was unconscious of what she was doing. From this time until September 28 from one to five needles were removed daily from the breast. Menstruation then occurred again, and was characterized by a similar attack of mental disturbance. After this, during the months of October and November, needles were taken from various parts of the body; from the left breast, abdomen, and mons veneris, labia, vagina, thighs, legs, buttocks, from about the anus, and from the back; 286 needles or pieces were removed from her body during life, 11 were found in the tissues after death, and 3 were passed per rectum during her illness, making a total of 300 needles and pieces. All the needles removed were rusty and bore evidence of having been a long time in the body. In regard to the presence of this large number of needles in the body no information could be obtained. The patient persistently denied any knowledge of having introduced them either by the stomach or through the skin. They did not seem to have contributed in any notable degree toward producing the fatal result. During the whole period, to her final illness, she retained her flesh, though she ate and slept irregularly. She was at times irritable and petulant; at other times abnormally cheerful, gay and pleasant. About a month before death she had an attack of localized pneumonia affecting the lower portion of the right lung. This was accompanied by stridulous breathing, spasm of the glottis, globus hystericus, crying, and other hysterical manifestations. These were followed by an attack resembling muscular rheumatism, with great pain and hyperæsthesia of the surface. Right arm was swollen, hot, and extremely sensitive. She lost appetite and sleep, became much depressed, and gave up all hope of recovery. Tongue became dry and brown, pulse rapid, secretions offensive, and mind very feeble. Diarrhœa supervened

and evacuations from the bowels and bladder were involuntary. She became unconscious and finally comatose, and died December 25, 1871.

Postmortem Examination.—Rigor mortis present, body well nourished; anterior surface studded with small cicatrices. Small abscess in the abdominal wall was filled with pus and contained one needle. Peritoneum was not inflamed. Head: arachnoid opaque and thickened over right hemisphere. Left hemisphere was covered by a thin layer of pus, contained in the subarachnoid space. Marked depression of convolutions at vertex of both hemispheres. Brain-substance was firmer than normal. Ventricles were empty. Choroid plexus contained numerous small cysts upon its surface, which were filled with serum. Thorax: lower lobe of the right lung was hepatized; a whole needle was found in the left lung. Abdomen: liver was soft and fatty; spleen enlarged; kidneys normal; stomach normal.

ALCOHOL (ETHYL HYDRATE).

Alcohol is **produced by** the fermentation of substances containing grape-sugar. It is official as a liquid containing 91 per cent. by weight and 94 per cent. by volume of ethyl alcohol, and the remainder of water. Absolute alcohol—that is, alcohol which is entirely free from water—cannot be prepared by distillation. The pure alcohol thus produced contains 11 per cent. of water.

Properties.—Absolute alcohol is described as a colorless volatile liquid of an agreeable odor and burning taste, boiling at 78.4° C. and not congealing at a temperature of —166°. It unites in any proportions with ether and water. It is capable of dissolving a very large number of substances both mineral and vegetable. With some acids it reacts chemically, forming the ethyl ethers. It is official in the following forms:

Alcohol containing 94 per cent. by volume;

Dilute Alcohol containing 50 per cent.;

Spiritus Frumenti (Whiskey) containing from 50 to 58 per cent.;

Spiritus Vini Gallici (Brandy) containing from 46 to 55 per cent.;

Vinum Rubrum (Red Wine) containing from 10 to 12 per cent.;

Vinum Album (White Wine) containing from 10 to 12 per cent.;

Vinum Album Fortior (Stronger White Wine) containing from 20 to 25 per cent.

A large number of **other preparations** are found, such as—

Gin with 40 to 50 per cent.;

Rum 40 to 50 per cent.;

Beer from 1 to 8 per cent.;

Cider about 6 per cent., and a large number of wines. The sweet wines contain undecomposed sugar, while in the dry wines this sugar has been converted into alcohol.

The **alcoholic habit** is so common that poisoning by its use is more frequently found than is poisoning from any other source.

Homicidal and **suicidal poisonings** are extremely rare, if they ever occur, but a form of **criminal poisoning** in which alcohol or one of its stronger preparations is given to infants, children, or others unaccustomed to its use, and which is followed by death or serious symptoms, is not very uncommon. Accidental poisoning among the same classes of individuals is not uncommon, and more or less chronic alcoholic poisoning is frequently found.

Alcohol and alcoholic liquors are frequently **adulterated** with **fusel oil (Amyl Alcohol)**, and the danger of acute poisoning is increased in direct proportion to the presence of this material.

Poisoning by alcohol may be either **acute or chronic.** In the acute form the symptoms are due to its direct action upon the nerve-centres; in the chronic form its effects are manifested more generally upon the various organs as well as the nervous and circulatory systems.

Acute Alcoholic Poisoning.—Acute poisoning by alcohol is the

Alcohol. 575.

result of the taking of a single large dose or of repeated smaller doses taken within a short period of time. The symptoms presented will depend upon the amount, character, and rapidity of the dose, together with the susceptibility of the individual. They will vary from the ordinary symptoms of drunkenness to those of acute narcotic poisoning, the most common being irritation of the gastro-intestinal tract, muscular incoördination, weakness, and hallucinations; the temperature is as a rule lowered, unconsciousness and coma follow. If a large quantity of concentrated alcohol is taken and the stomach is not relieved by vomiting, collapse and death may follow. The pupils are as a rule dilated, the conjunctivæ congested, respiration stertorous, and there may be a considerable amount of lividity. Convulsions may sometimes appear, and death may follow either from paralysis of respiration or from overstimulation of the heart. Death may occur within one-half hour after the taking of the toxic dose. In some instances a considerable amount of froth may appear upon the lips.

Symptoms.—Acute alcoholic poisoning presents very much the same symptoms, and may be readily confounded with injury to the brain in the form of apoplexy, concussion, or compression; and when the diagnosis is to be made, two things should be remembered: first, that injury to the brain is very apt to occur in alcoholic subjects, and the fact of an alcoholic odor of the breath does not eliminate the possibility of cerebral injury; and second, that in cases of acute alcoholic poisoning the cerebral symptoms are largely due to intercranial pressure dependent upon either congestion or œdema, and it may be extremely difficult, if not impossible, to decide as to whether the cerebral compression is due to the extravasation of blood or to the exudation of serum. The dilated pupils may be due either to paralysis by alcohol or paralysis from cerebral pressure. At times a differential diagnosis is impossible to make.

Treatment.—The stomach should be emptied of its contents; strychnine, ammonia, or other stimulant administered. Black coffee is sometimes indicated; fresh air, artificial respiration, and electricity.

Postmortem Appearances.—The blood is as a rule fluid. In the very acute cases decomposition is usually slow. Where alcohol in a concentrated form has been used, congestion and inflammation of the stomach and upper intestine will be found. The kidneys, liver, spleen, and brain will be congested; œdema will usually be found in the membranes and ventricles of the brain.

Tests.—The odor of alcohol may be usually detected, and is, when associated with a history consistent with such poisoning, perhaps the most valuable test that we have. In certain cases alcohol may be recovered from the contents of the stomach by distillation. If the pure alcohol can be obtained by distillation, it will react to the ordinary tests, giving the odor and taste, burning with a pale-blue flame, leaving no residue, and dissolving camphor. If to alcohol a solution of potassium dichromate and sulphuric or hydrochloric acid be added, an emerald-green color will be produced together with the peculiar odor of aldehyde. It is also possible to detect it in the blood, tissues, and urine by means of Bucheim's method.

Chronic alcohol-poisoning is usually due to the taking of alcohol in one of its varied forms for a period of years. As a result of such chronic poisoning changes take place in the various organs, and together with those of the circulatory and nervous systems vary in their extent and character to an almost unlimited degree. The presence of alcohol in the blood more or less constantly for many months or years results in changes in the organs, usually in the form of an increase in the connective tissue. As a result of these changes conditions are presented which simulate or duplicate those produced by various forms of disease which may not be the result of alcohol. Such changes in the kidneys, liver, stomach, and brain are perhaps most definitely marked and appreciated. It is impossible to say from the presence of any one of these conditions that it was the result of chronic alcoholic poisoning, but when taken together, especially if combined with acute poisoning, the combination may be sufficient upon which to base a diagnosis.

Illustrative Case of Acute Alcohol Poisoning.—Coltart (*Birmingham Medical Review*, 1899, xlv. 157) reports a case of acute alcoholic poisoning in a child resulting in death. Male, aged four years, was admitted into the hospital unconscious at 10.30 A. M., with a history of having drank, about one hour previously, about 5 ounces of neat brandy. He was found a few minutes after swallowing the brandy standing with the bottle in his hand, and apparently quite sensible. Almost immediately he lost consciousness. On admission he was unconscious and could not be roused; face flushed, pupils contracted, and conjunctival reflex absent. He vomited about two ounces of what appeared to be pure brandy. The stomach-washings smelt strongly of the same spirit. Pulse regular, slow, full, and of moderate tension. Temperature 94° F. During the next three hours little change was noticed except a steadily rising temperature and the vomiting of a little dark-red fluid which gave the guaiacum reaction. Five hours after admission the temperature had risen to 97.6° F., and an hour and a half later the first signs of cerebral irritability were shown in two attempts at convulsions. At 6 P. M. Cheyne-Stokes respiration set in, and continued more or less typically until death. Temperature steadily rose. Two definite convulsions occurred, producing opisthotonos and extension of arms. At 10.30 P. M. there was coarse twitching of the right side, principally affecting the arm. Respiration quick and regular. Pulse 82. Temperature 101.2°. He vomited at intervals during the night, but there was no evidence of enteritis. At 12 midnight temperature was 103°; at 1 A. M. 105°, which was reduced to 101.8° by sponging. Ice-bag was applied to head and chloroform controlled the convulsions, but was not kept up owing to their mild character. At 7 A. M. heart was failing and there was much secretion from the bronchial tubes. Pulse could scarcely be counted, about 150. Strychnine every two hours. At 11 A. M. the abdomen was rather distended and tense; bladder empty. Temperature 100.8°. Child died at 3 P. M., having two severe general convulsions before death. Had been pulseless since 12 M.

Postmortem Examination.—Brain: dura rather tense; convolutions a little flattened. Considerable blood-stained fluid in sinuses; slight tendency to clot in lateral sinus. Pia injected; fair amount of clot in basilar artery. Pons normal. Fourth ventricle normal. Medulla and spinal cord normal. Abdomen contained a large number of enlarged mesenteric glands. Spleen was enlarged, dark, and flabby. Malpighian bodies very distinct. Stomach very contracted; its mucous membrane was healthy. Duodenum healthy. Walls of intestine were very thin and showed the solitary follicles very distinctly. Ileum was of a greenish color and showed opaque patches in lower part. Liver pale, lobules of a chocolate color; no gross change, but microscopically intense and acute fatty degeneration was seen in the liver-cells. Kidneys: cortex healthy; capsules not free, and left a granular surface when peeled. Microscopically there were much cloudy swelling and commencing epithelial disintegration. Urine contained a cloud of albumin. Thorax: both lungs showed extreme congestion at their bases; not much œdema. Heart: right auricle contained much loose clot.

Illustrative Case of Chronic Alcohol Poisoning.—Draper (*Transactions Massachusetts Medico-Legal Society*, Boston, 1878–88, i. 37) relates a case of sudden death in a woman subject to alcoholism. The dead body of a middle-aged woman was found lying at full length upon the floor of her kitchen early in the morning of November 26. The woman had been indulging in a drunken spree during the previous fortnight; and spent the day before her death in a carouse with two men, consuming ale and whiskey freely. The men succumbed to the liquor and left the woman sitting at the table, very drunk. On awakening next morning they found that she had died some time during the night. Both men asserted that there had been no quarrel or violence of any kind.

Postmortem Examination.—A number of small bruises were found on the body, none of which seemed to be recent. Brain and its membranes were injected to a moderate degree; there was no extravasation of blood, meningeal or cerebral. Except a small surface at the base of the right lung bound

down by old pleuritic adhesions, the lungs were healthy. Trachea and bronchi normal. Heart healthy. Blood was fluid and of dark color. Kidneys presented the typical appearances of chronic inflammation; they were lessened in size, their cortices were thin, their capsules removed with difficulty, leaving the surface granular; they were hyperæmic on section. Spleen and intestines normal. Liver was mottled, dense, and injected. Uterus was enlarged and its mucous membrane was hypertrophied and congested. Entire mucous membrane of the stomach showed intense hyperæmia, without erosion at any point; these appearances were most marked at the fundus. The minute disseminated ecchymoses were too numerous and too uniformly spread to be accounted for by digestion or by postmortem changes. Œsophagus was reddened at its lower extremity, but elsewhere was unaltered. The stomach contents, blood, brain, and the thoracic viscera imparted a distinct alcoholic odor.

Anæsthetics.

Under the head anæsthetics are included those cerebral neurotics whose most marked effect is the production of unconsciousness and insensibility to pain, the most important of these being ether, chloroform, chloral hydrate, nitrous oxide, and ethyl bromide.

ETHER.

Ether, or, as it is sometimes called, **sulphuric ether**, is a fluid containing about 74 per cent. of ethyl oxide, about 26 per cent. of alcohol, and a little water.

It occurs as a clear diffusive, thin colorless liquid with a characteristic odor, a burning and sweetish taste, and a neutral reaction. It is soluble in alcohol, chloroform, benzol, benzine, and the oils. It boils at 37° C. (98.6° F.), is highly inflammable, and when its vapor is mixed with air and ignited it explodes violently. It is extremely volatile, and when exposed to air evaporates rapidly with the production of cold. It dissolves corrosive sublimate rapidly, iodine and bromine

freely, and sulphur and phosphorus slightly. It does not dissolve potassium and sodium, so differing from alcohol. It is used in medicine largely as a solvent in small internal doses in certain forms of nausea. It is an active cardiac stimulant in small doses. Its most common medicinal use is as an anæsthetic.

Symptoms.—Symptoms of ether intoxication and poisoning are very similar to those produced by alcohol, there being three stages: first, stimulation; second, delirium and excitement; and third, narcotism. The duration of these stages and the amount of ether required to produce them vary in different individuals. A person who has become accustomed to the use of alcohol requires considerable more ether to accomplish the same result than one who has not been so accustomed. During the first stages of stimulation the pupils are dilated, but contract on exposure to light; the pulse is increased in rapidity and force. The pupils then contract, and later, when poisoning of serious form appears, the pupils dilate and become more or less inactive to light according to the degree and duration of the poisoning, respiration is stertorous, the color is cyanotic, and the pulse becomes more rapid and of poorer quality. During all of these stages anæsthesia is much more marked than it is in the corresponding stage of alcohol, and during the narcotic stage before the active symptoms of poisoning appear sensation and voluntary motion are entirely wanting. Death may result from paralysis of any of the involuntary muscles, but is more common from paralysis of respiration, and more rarely from paralysis of the heart. Suicidal and homicidal poisonings with ether are extremely rare, and in proportion to the frequency of its use, accidental poisonings must be rare. When taken internally, ether acts as a violent irritant, and the symptoms presented are burning pain in the œsophagus and stomach; frequently there is vomiting, followed by unconsciousness and death if the dose be sufficient. Ether-drinking for purposes of intoxication is said to be common in some localities. Accidental deaths from the inhalation of ether occur at rare intervals.

Treatment.—When ether has been taken into the stomach and serious symptoms have developed, the stomach should be

emptied of its contents, cardiac and respiratory stimulants given, and artificial respiration and fresh air persisted in until consciousness returns. When it has been inhaled and the poisonous stage has been reached, artificial respiration and fresh air should be given.

Postmortem Appearances.—When death has occurred from inhalation of ether there will be few if any local signs; the brain is congested, and if an autopsy be made within a very short time after death, the odor of ether may be detected. When ether has been taken by the mouth in fluid form, an active irritation and inflammation will be found in the œsophagus, stomach, and upper intestine.

Tests.—Ether may be recognized by its odor, its volatility, its inflammability, burning as it does with a smoky flame, and the green color which is produced if potassium bichromate and dilute sulphuric acid are added to its solution. It may be extracted from the contents of the stomach in the same way as alcohol.

Illustrative Case of Ether Poisoning (Inhalation).—Roberts (*Proceedings Philadelphia County Medical Society*, 1880–81, iii. 87) reports a case of ether death. A woman, aged twenty-six, was admitted to the hospital with fibrous ankylosis of the right knee and hip, subsequent to arthritis, which had existed for about a year. She had also been treated for chronic uterine disease, rheumatism, cardiac palpitation, and nervous prostration. On January 20 she was placed upon the operating-table for the purpose of having the fibrous joint-adhesions broken up by passive motion. She was frightened and very nervous, but stated that she had often taken ether. On auscultation it was found that the heart's action was rapid and tumultuous, as would be expected from her excited condition, and it was thought that an indistinct murmur could also be detected. Nothing sufficient to contraindicate anæsthesia appeared to be present. Ether was administered slowly; the patient at first not breathing very deeply, but in a short time she passed into a condition of anæsthesia without the least struggling. The adhesions were broken up and an extension apparatus adjusted to the limb.

Just before she was taken from the table, and while she seemed to be sleeping quietly, it was noticed that the pulse was frequent and very feeble. The etherization, operation, and the application of the apparatus took about half an hour: 2 to 2.30 P. M. The patient was transferred to the ward, where it was found that she was still unconscious, breathing quietly and regularly; pulse very feeble, 180–200 per minute: respiration about 22. In spite of all treatment the patient continued to sink, and died quietly at 3.35 P. M. without having shown signs of consciousness and without voluntary motion of the limbs from the time anæsthesia was produced. Shortly before death some cyanosis of the hands was noticed and the respiration became somewhat irregular.

Postmortem Examination (*twenty-one hours after death*).—There was a small amount of pleural effusion, but almost no pericardial. Heart cavities contained fluid blood; ventricles not firmly contracted. There was slight dilatation of both auricles and the left ventricle, and some thickening of the walls of the left auricle and right ventricle. Left ventricle was normal. Coronary arteries were filled with blood. Two spots of ecchymosis were found on the surface of the heart. Cardiac muscle was much softened. Valves of right side were normal, though the auriculoventricular orifice was dilated. Mitral leaflets were normal; the orifice was dilated. Aortic sinuses seemed pouched. Oval fossa presented an oblique opening large enough to allow the passage of an ordinary lead-pencil. Lungs crepitated poorly, and were congested posteriorly; anteriorly they were pale in color. No œdema. Both lower lobes posteriorly were softened, but not granular. Spleen normal. No perceptible odor of ether about the viscera. Left kidney was irregular, moderately firm, deeply congested, showing on section no alteration of cortex, but having an adherent capsule and some subcapsular ecchymoses. Surface was but slightly granular. At several points in the pyramidal portion areas of softening, from which drops of mucoid material could be pressed, were seen. Right kidney was softened and presented appearances similar to those found in the left. Liver had smooth surface, was

moderately congested and softened. On the anterior surface of the right lobe, near the middle, was a nonprotruding cyst, filled with dirty-brown gelatinous material. Ovaries showed marked cystic disease. Bladder empty.

Microscopic Examination.—Heart-muscle showed evidences of granular and fatty degeneration. Sections of lung-tissue showed appearances very similar to those of embolism, though no embolus of either fat or blood could be found. Lung epithelium showed no change, but the peribronchial connective tissue was increased. Kidney capsules showed no evidences of thickening. Arteries appeared slightly enlarged and their walls thickened. Capsules of the Malpighian bodies were thicker and firmer than usual, and around them nuclear proliferation had taken place. Within the Malpighian body proliferation was likewise taking place, similar to that seen in glomerulonephritis. Intertubular tissue was slightly swollen and its nuclei were more distinct and numerous than usual. The convoluted tubes were slightly irregular in outline: their basement-membranes unchanged; their epithelia swollen, markedly granular, with nuclei in most instances indistinctly visible. Capsule of liver was thickened, and showed active proliferation into the interlobular connective tissue. Liver-cells appeared slightly shrunken and highly granular; their nuclei were visible, but stained poorly. The cells presented appearances of fatty degeneration.

CHLOROFORM ($CHCl_3$).

Chloroform may be produced by the action of chlorinated lime on alcohol, usually assisted by sulphuric acid, calcium chloride, and water. It occurs as a heavy, clear, and colorless, diffusive liquid with a characteristic odor, burning, sweet taste, and a neutral reaction. It is soluble in about 200 parts of water, and freely soluble in alcohol, ether, benzol, benzine, and the oils. Its specific gravity is 1.485. It boils at 60° C. (140° F.), and has extensive solvent powers. As a general solvent it has the advantage of ether in that it is not inflammable. It is a strong antiseptic and has the power of

preventing alcoholic, lactic, and other fermentations. It is used largely in medicine internally on account of its stimulating and antifermentative action, externally as a counterirritant, and by inhalation as an anæsthetic.

It has been the agent in a very considerable number of cases of accidental, suicidal, and homicidal poisonings. It may cause death either when taken internally or when inhaled.

Symptoms.—When applied externally it acts rapidly as an irritant, especially when evaporation is absent, setting up a hot, burning pain within a short time after its application. Later it acts as a local anæsthetic, and if its use is continued will result in blistering. When taken internally, its first action is that of a violent irritant, followed within a comparatively short time by symptoms closely resembling those seen after its inhalation. It has in a number of instances caused death from taking in this way. When inhaled, its action is much more rapid than ether; the stage of stimulation is not so well marked, neither is that of excitement. The first effect upon the pulse is that of a mild stimulant; later, during the process of anæsthesia, the action of the pulse is usually less strong. As the severe symptoms of poisoning come on, respiration becomes stertorous, color cyanotic, pulse weak and rapid, and death usually occurs from cardiac paralysis. The chloroform-habit has been acquired by a considerable number of people, and under such circumstances a large quantity can be taken either internally or by inhalation without serious effects.

Dose.—Internally 1 drachm has caused death in a number of instances, especially in children. Deaths have frequently occurred from doses of from ½ to 1 ounce.

Treatment.—When dangerous symptoms occur during the inhalation of chloroform, it should be stopped, the body elevated, and artificial respiration and cardiac stimulation by means of drugs, alcohol, and electricity are indicated. Atropine hypodermically administered is said to have an especially good effect. If it has been taken internally, the case should be treated as one of irritant, narcotic poisoning, the stomach emptied, and stimulants and artificial respiration persisted in.

Postmortem Appearances.—Where death has occurred from the introduction of liquid chloroform into the stomach, the signs of irritant poisoning will be found in the œsophagus, stomach, and upper intestine. The odor of chloroform may be detected in these cases even after a considerable length of time. There may be signs of death by asphyxia even if it has not been inhaled. When chloroform has been inhaled, there are no characteristic signs. The appearances of asphyxia may be present and the odor of chloroform may be recognized, but this odor does not persist so long after its inhalation as it does when it has been taken in its fluid state. The blood is usually dark and fluid, and there may be a considerable amount of congestion of the kidneys. Putrefaction is somewhat delayed and cadaveric rigidity is prolonged.

Tests.—Chloroform may be recognized by its insolubility in water except in small quantities, its characteristic odor and taste, its marked solvent action on such substances as camphor, rubber, and gutta-percha, and the light-yellow color which is produced when it is shaken with ether. When heated, chloroform is changed into chlorine and hydrochloric acid. If during the process of distillation a piece of moistened litmus-paper is placed near the mouth of the tube, it is first reddened and then bleached. Starch-paper moistened with potassium iodide is changed to blue under the same conditions. If the vapors of distillation are passed through a solution of silver nitrate, there will be a white precipitate of silver chloride.

Illustrative Case of Chloroform Poisoning (Inhalation).—Stevenson (*Guy's Hospital Report*, London, 1868, xiv. 261) reports a death from the inhalation of chloroform. Male, aged thirty-three, powerful and muscular, and who had always enjoyed good health, was admitted to the hospital on September 12 for an old distortion of the ankle-joint. He expressly stipulated that chloroform should be administered before the operation, concealing the fact that eight years before he had nearly died from the effects of that anæsthetic. On September 16 chloroform was given by means of an inhaler. For about two minutes he took the chloroform

quietly and seemed to be becoming insensible in the ordinary manner. He then began to struggle violently; this continued for about a minute; he ground his teeth and his face became much congested. During this time the anæsthetic was freely given. Pulse could be felt with difficulty during the stage of excitement, but at its close it became intermittent. He then became insensible, the chloroform was withheld, and the operation was commenced. Pulse became regular, 60 per minute. He continued this way for about a minute and a half, when, after ten or twelve intermittent beats, the heart ceased pulsating. Artificial respiration and other means of resuscitation were employed, but without avail. For three or four minutes he continued to give an occasional deep gasp; but finally all signs of life ceased.

Postmortem Examination (*twenty-four hours after death*).—Rigor mortis was present in the lower and but feebly in the upper extremities. Face bore a placid smile, was deeply congested; the ears and neighboring parts were quite black. The chest, neck, shoulders, etc., were extensively ecchymosed, the ecchymoses being diffuse, mottled, and of a deep violet hue. Scrotum was also ecchymosed. Eyelids were deeply injected. Cranium: the sinuses and vessels were gorged with dark fluid blood which scarcely coagulated even after some hours; two or three small ecchymotic patches were noticed beneath the arachnoid. Lungs were very much gorged with blood posteriorly, from postmortem gravitation, and there were also several apoplectic spots showing that before death there must have been considerable obstruction to the pulmonary circulation. Heart was nearly empty, but not contracted. Cardiac tissue was healthy and valves perfect. Muscular tissue showed on microscopic examination signs of incipient fatty degeneration. Liver and kidneys congested. In the pelves of the kidneys punctated ecchymosis was present in its most typical form. Larynx was healthy.

Chemical examination of the blood, liver, and brain-tissue resulted in the detection of chloroform therein.

CHLORAL HYDRATE (CHLORAL, $C_2FCl_3O.H_2O$).

Anhydrous chloral is usually prepared by the direct action of chlorine gas upon alcohol. Chloral hydrate, or chloral, as it is commonly known, results from the mixing of anhydrous chloral with water.

It occurs in commerce either in distinct crystals or crystalline plates, is white, and has a peculiar, pungent odor, and an acrid taste. Exposed to the air it very slowly volatilizes; it boils at 97.5° C. Pure chloral does not take fire when heated in a spoon, but evaporates without residue. It is freely soluble in water, alcohol, ether, also in chloroform, glycerin, benzol, etc. It liquefies when mixed with carbolic acid or camphor.

It is used in medicine as a sedative and hypnotic, and is the active principle in many proprietary remedies, especially for nervousness, delirium tremens, etc. Danger from its use is increased by the varying ways in which different individuals are affected, some being much more susceptible to its action than are others.

Action.—Under ordinary conditions when in doses of from 15 to 30 grains it produces a quiet, placid sleep within from ten minutes to one-half hour, which usually persists for from two to four hours. In some instances, however, even so small a dose as 20 grains has produced serious symptoms. When larger doses are given, the sleep is much deeper and may develop into coma. The respirations are slower and the pulse is weak and slow; if, however, the dose is a toxic one, or on account of cardiac disease or idiosyncrasy on the part of the patient, it acts as a marked cardiac depressant, the rate is increased and the force much diminished, pupils contracted at first but afterward dilated, and fatal results may follow within a very short time. Death may occur by paralysis of the heart or respiration.

Dose.—As has been said, in rare instances serious results have followed the taking of 20 grains, and many instances have occurred in which death followed the taking of from

50 to 100 grains. Cases are reported in which life has been saved after the taking of 150 to 180 grains.

Treatment.—The temperature of the body should be kept up by artificial heat, drug stimulants to the heart and respiration are indicated, and respiration should be kept up by artificial means. If paralysis of respiration is an important symptom, picrotoxin has been recommended as an antidote.

Postmortem Appearances.—There are few characteristic lesions produced by chloral hydrate poisoning. There is usually congestion of the brain, but this is not necessarily present. The odor of either chloral hydrate or chloroform may usually be detected even after the lapse of considerable time.

Tests.—When a solution containing chloral is rendered alkaline and then heated, chloroform is produced, which may be recognized by its odor and tested for as described under chloroform.

Illustrative Case of Chloral Hydrate Poisoning.—Hunt and Watkins (*British Medical Journal*, London, 1871, i. 193) report a chronic case of poisoning by chloral hydrate. A clergyman, aged fifty-one years, subject to dyspepsia, commenced taking chloral at night on November 15, 1870, the dose at first being 20 grains, combined with the same amount of potassium bromide. This dose was gradually increased, but to what extent and how rapidly was uncertain, and the bromide was omitted. He at first had the prescription dispensed by a chemist, but afterward procured from him the chloral in one ounce bottles. He informed the chemist that on one occasion, after taking three doses in one night, he had felt weak in his extremities the next morning, having fallen down twice on getting out of bed. On January 27, 1871, he was found dead in bed at 8.30 A. M. When seen by Mr. Hunt at 9 A. M. the face was perfectly calm and pale, covered with profuse perspiration, and no appearances of any struggle or vomiting. His housekeeper had often seen him dissolving the chloral in water in a half-pint bottle, from which he was in the habit of taking a wineglassful at bedtime; but she did not know the quantity of chloral dissolved each time. She

had seen him take a dose from the bottle the night before his death. It was estimated he had taken in the ten days between January 17 and 27 14 drachms of chloral.

Postmortem Examination (*fifty-four hours after death*).—Body was fat and well nourished. There was no decomposition. Heart was normal in size and appearance, covered with fat about the auricles and on the ventricular septum. On the left ventricle anteriorly there was a white patch in the investing membrane about the size of a thumb-nail and perfectly smooth. Lungs and pleura normal. Liver and gall-bladder normal. Stomach was distended; its pyloric end was of a uniformly pink color anteriorly, and posteriorly there was increased vascularity about the cardiac extremity and along the lesser curvature, with minute extravasated patches of claret-colored blood under the mucous membrane at the cardiac extremity. No thickening or ulceration of the mucous membrane. Pylorus healthy. Stomach contained about three-quarters of a pint of thick fluid, with very small pieces of fat and red muscular fibre partly digested. Kidneys normal and surrounded by fat. Bladder contained about half a pint of urine. Brain: the cerebral membranes were adherent to a small extent on each side of the superior longitudinal sinus, with some old deposits of fibrin. The membranes generally were much congested and contained about one ounce of red serum. The convolutions were remarkably large and pale. The brain-substance was pale, very soft, and friable. There was no increased vascularity in any part, except the choroid plexus; no effusion in the ventricles, or extravasation of blood. Large and small intestines normal.

NITROUS OXIDE (NITROGEN MONOXIDE, LAUGHING GAS, N_2O).

Nitrous Oxide is a colorless nearly odorless gas, slightly sweet to the taste, with a specific gravity of 5.127. It is produced by the action of heat on ammonium nitrate.

It has been for many years used as an anæsthetic, particu-

larly in dentistry, for the extraction of teeth. Cold water will absorb about three-fourths of its bulk of the gas, and under pressure much more. In this form nitrous oxide water, which consists of water impregnated under pressure with about five times its volume of gas, has been used, especially in England, as a diuretic and stimulant. As an anæsthetic its action is apparently due, at least to a very large extent, to interference with the supply of oxygen. Notwithstanding this fact it is a very safe anæsthetic, and deaths from its action are extremely rare. When they do occur, they are the result of asphyxia, and the postmortem appearances, etc., are those of asphyxia.

Illustrative Case of Nitrous Oxide Poisoning.—Adams (*Lancet*, London, 1894, i. 738) reports a case of death under nitrous oxide gas. Male, aged twenty-six years, went to a dentist on February 21 about 1.30 P. M., to have a tooth extracted. He had partaken of a light lunch about one hour previously and seemed to be in good health. After taking three or four inspirations of the gas he took off the face-piece and said that he felt nervous, but the administration of the gas was continued at his request. Respiration was shallow but regular, and after taking about two-thirds of the usual amount of gas the tooth was extracted quickly and without difficulty; respiration at once became irregular and the patient became more cyanosed, muscles rigid, and he ceased to breathe. Artificial respiration was resorted to within thirty seconds after the extraction. Heart was beating regularly but not strongly; body remained rigid; but there was no inspiratory effort. About two minutes after the extraction two or three expirations took place, showing that there was no considerable obstruction in the larynx. All other measures failing, tracheotomy was performed within three minutes of the time the gas was discontinued, and an opening was made through the upper rings of the trachea without loss of time. The tracheal wound was kept open, and on resuming artificial respiration a quantity of mucus (about an ounce) was forced out. Although air could be heard passing in and out of the tracheal opening there was no

voluntary effort of breathing from first to last. The patient now became still more cyanosed and the heart could no longer be heard beating. Artificial respiration was kept up for twenty minutes longer, although there was little hope of its being of any use.

Postmortem Examination (*twenty-five hours after death*).—Face, neck, and back were deeply cyanosed. On removing the skull-cap venous engorgement was visible on the surface of the cerebral hemispheres. Brain-substance normal. On opening the chest it was noticed that everywhere the veins were full of dark fluid blood. Heart normal and all the cavities empty, except for a small quantity of fluid blood in the right ventricle. Lungs were engorged with dark fluid blood, and were nearly free from air. Mucous membrane of the bronchi was engorged and of a dark color. A quantity of thick mucus was found in all the larger bronchi. Trachea was engorged but contained less mucus. Larynx showed no swelling and very little engorgement; contained no appreciable amount of mucus; no foreign body or abnormal substance was found. Tonsils showed old enlargement but did not meet in the middle line. Stomach contained a small quantity of undigested food with a good deal of ropy mucus. Liver, kidneys, and spleen were all dark in color, showing venous engorgement, but without any signs of disease. Bladder empty.

ETHYL BROMIDE (HYDROBROMIC ETHER, C_2H_5Br).

Ethyl Bromide is a colorless volatile liquid, not inflammable, with an agreeable odor and a hot sweet taste. Its specific gravity is 1.420. It boils at 40° C., and is slightly soluble in water, freely soluble in strong alcohol and ether, with a neutral reaction.

Ethyl bromide has been used as an anæsthetic. At one time its use was becoming common, but on account of several deaths which took place during its administration it is now used much more rarely. Its action upon the heart and as an anæsthetic is very similar to that of chloroform, but its use

is apparently associated with rather more danger. It is a rapid anæsthetic, even more so than chloroform. Experimentally it has been demonstrated that when injected into the veins of animals it produces death by syncope.

Illustrative Case of Ethyl Bromide Poisoning.—Wilson (*Medical and Surgical Reporter*, Philadelphia, 1880, xliii. 117); and Roberts (*Proceedings Philadelphia County Medical Society*, 1880–81, iii. 90) report a case of death from bromide of ethyl. Boy, aged eighteen years, was admitted to the hospital for lithotomy. He was in bad condition, and the operation therefore was deferred until his general health could be improved somewhat. After several weeks' stay in the ward, and upon the approach of summer weather, the patient protested against further delay. On May 26, after the administration of a stimulant and 15 grains of quinine, two fluidrachms of ethyl bromide were given. Soon after, the patient struggled, when a third drachm was given. A fourth drachm was given later, and anæsthesia was accomplished. The cutaneous incision had just been made when it was noticed that respiration was imperfect. When the towel was removed from the face the lips were noticed to be of a pinkish color, and no marked cyanosis was present. A few feeble inspiratory efforts took place, but all measures were of no avail and death ensued.

Postmortem Examination (*two hours after death*).—Commencing rigor mortis. Tissues of scalp congested; membranes of brain congested; ventricles contained a small amount of clear serum; brain-substance normal; membranes of medulla anæmic. No odor of ethyl bromide perceptible in brain. On opening the body the odor of ethyl bromide was noticeable. Apex of left lung was bound to the thoracic walls by old pleuritic adhesions. Upper lobe was partially consolidated; the lung-tissue contained a number of cavities, with caseous and purulent deposits. Right lung bound down by old pleuritic adhesions. Lung-tissue consolidated and filled with cavities of various sizes. Trachea and bronchi contained a small amount of pus, otherwise normal. Right side of heart dilated; auricle and ventricle contained post-

mortem clots. Concentric hypertrophy of left ventricle, which was contracted. Kidneys enlarged, left diseased. Liver and intestines normal. Concentric hypertrophy of bladder, which contained at its neck two encysted calculi.

Microscopic Examination.—Kidneys showed inflammation of pelvis, extending to the entire organ. Morbid process in the lung was catarrhal pneumonia; no tubercular deposits.

METHYLENE BICHLORIDE.

Methylene Bichloride, CH_2Cl_2, is a colorless liquid with an odor resembling that of chloroform; its specific gravity is 1.344, and its boiling-point 40° C. It is volatile, the vapor burning with a brilliant flame, and gives off during its combustion carbonic and hydrochloric acids. It has a neutral reaction. This substance has been used to a moderate extent as an anæsthetic, but it has apparently been demonstrated that it is not so safe as chloroform or ether, several cases of death having been produced by it during its somewhat limited use.

Illustrative Case of Methylene Bichloride Poisoning.—Hughes (*Lancet*, London, 1890, ii. 768) reports a case of death occurring during the administration of methylene. Male, aged fifty-one years, was admitted to the hospital on September 3, suffering from necrosis of the left tibia and disorganization of the left ankle-joint. He gave a history of syphilis sixteen years previously. There had been some necrosis of the right tibia and the nasal septum was almost completely destroyed. He was prepared for amputation of the leg on September 5 at 1 P. M.; two hours previously an ounce of brandy had been given to him. Methylene was administered, and after three or four inhalations, when about 3 drachms had been given, he commenced to struggle violently and became very cyanosed. About a minute later he ceased struggling, the color of the face changed to a leaden hue, and the pulse and respiration ceased. Artificial respiration was kept up for half an hour; brandy and ether were injected; heat and the electric current applied over the heart, but without avail. At the commencement of artificial respiration he gave two deep-

drawn gasps, but otherwise showed no signs of life. He appeared to die from sudden syncope.

Postmortem Examination.—Brain normal. Lungs much congested and œdematous at the base. Ventricles of the heart were dilated, with very thin walls; heart-substance was very light colored, soft and friable; endocardium pale; no valvular lesions. The ventricles were in diastole and contained fluid blood. Kidneys large and congested. Spleen enlarged, and at one spot presented the cicatrix of an old gumma. Liver was small, hard, and cirrhotic.

QUESTIONS.

Describe poisoning by opium and morphine.
By alcohol.
By ether.
By chloral.
By nitrous oxide.
By ethyl bromide.
By methylene bichloride.

CHAPTER X.

SPINAL AND CEREBROSPINAL NEUROTICS.

NUX VOMICA AND STRYCHNINE.

Nux Vomica is the name applied in medicine to the seeds of *Strychnos Nux Vomica*, or poison nut, a tree which is a native of the East Indies. The two active principles which have been isolated from it are *Strychnine* and *Brucine*. Strychnine is also found in several other trees of the species *Strychnos*. Brucine is analogous in its action to strychnine, excepting that it only has about one-twelfth its strength.

These two substances, nux vomica and strychnine, are, perhaps, the most important and the most commonly used of all the neurotic poisons. Nux vomica is largely used in medicine as a bitter tonic, and poisoning not infrequently occurs, the symptoms and conditions presented being those due to strychnine and brucine; they will be considered under the head of strychnine.

STRYCHNINE.

Strychnine, as it is officially described, occurs as colorless, octahedral or prismatic crystals, or a white crystalline powder, odorless, having an extremely bitter taste, which may be perceived when diluted 700,000 times with water. It is soluble in about 7000 parts of water and 110 of alcohol. When heated to decomposition, it gives off a suffocating odor resembling that of asphalt. It has an alkaline reaction and forms salts with the acids. The most important salt of strychnine is the sulphate, which occurs as colorless or white prismatic crystals, odorless, and with the same bitter taste as strychnine, with a neutral reaction, soluble in 10 parts of water and 60 of alcohol. This salt is the one which is most commonly used in medicine, especially for hypodermic use on account of its solubility. Strychnine is one of the most valuable stimulants, especially to the cardiac muscle. It is a frequent cause of poisonings, suicidal, homicidal, and accidental.

Symptoms.—The symptoms from nux vomica, strychnine, and brucine are the same, so that they will be considered together, strychnine acting more rapidly than do the other two. The first symptom is that of uneasiness and restlessness, with a greater or less sense of impending suffocation. There is a trembling of the whole frame with twitching of the arms and legs. Tetanic convulsions come on rapidly and violently, all the muscles of the body being affected at about the same time. Opisthotonos is commonly present and results from tetanic spasm of all of the muscles. The face during one of these convulsive attacks presents a ghastly appearance (*risus sardonicus*), and the color becomes poor, on account of the difficulty in respiration. The convulsions increase in frequency and severity. The muscles of the lower jaw, which are the first to be affected in tetanus, are usually the last in strychnine-poisoning. The intellect is clear, and therefore the suffering during convulsions is much increased. During the intermission between the convulsions there are great thirst, pallor, and exhaustion. The attacks rapidly follow each other, and if death occurs, it usually does so within two hours

after the symptoms appear. Death may occur either during a convulsion or during one of the periods of rest. The mind is usually clear nearly up to the time of death.

Dose.—The susceptibility of individuals to the action of strychnine varies greatly. Cases have occurred in which even $\frac{1}{120}$ grain has caused symptoms of strychnine-poisoning, while $3\frac{1}{2}$ grains have been taken without causing death. The average medicinal dose is $\frac{1}{60}$ grain; $\frac{1}{16}$ grain has been fatal in a child between two and three years old; $\frac{1}{2}$ grain has proved fatal in an adult. It is probable that a grain may be considered as a fatal dose in the average individual, although it is said that recovery has followed the taking of very large amounts, even up to 40 grains. In these last cases, however, early vomiting probably removed most of the poison from the stomach before it was absorbed. The dose of nux vomica also varies: 3 grains of the alcoholic extract have caused death, as have 30 grains of the powder. The time elapsing between the taking of the dose and death is usually very short. One of the most rapidly fatal cases is reported by Taylor, in which the symptoms commenced in five minutes after taking $1\frac{1}{2}$ grains, and death resulted in twenty minutes. Christison mentions a case in which death occurred within fifteen minutes after the taking. Death usually occurs within two hours, but Reese reports a case in which life persisted six hours after taking 6 grains of strychnine in pill-form.

Treatment.—Early and complete evacuation of the stomach by vomiting and washing is most essential. If it can be washed out with strong tea or solutions of tannin, the chances of relief will be greater. The ordinary antidotes are chloral, chloroform, and the bromides, which may be given by the mouth or rectum. Atropine and amyl nitrite are also recommended. Anæsthesia by chloroform, in order to prevent convulsions and allow of treatment, is strongly recommended, and if persisted in has in several instances helped materially in the saving of life.

Postmortem Appearances.—The appearances found after death from strychnine-poisoning are not characteristic. Probably the most important is congestion of the brain and spinal

cord. This may be so extreme as to be associated with the effusion of considerable amounts of blood, or it may be entirely absent. The gastrointestinal tract is ordinarily normal, but in some instances it is markedly congested. The blood is usually dark and fluid, and the heart may be either contracted and empty, or dilated and full. The body is usually flaccid at the time of death, but rigor mortis comes on rapidly, and usually persists for a considerable period of time. According to Reese, it has been found existing six weeks after death. There is very apt to be a more or less livid color to the mucous membranes and extremities.

Tests.—When in pure solution one of the most delicate tests is that of taste. When even in extremely dilute solutions the very bitter taste may be recognized. This taste, however, may be covered by such materials as tannic acid, licorice, and chocolate. If strychnine in its pure form has been taken into the stomach in considerable quantities as an alkaloid or as a powder, portions of it may be usually detected on account of its limited solubility. When it is taken in the form of its salt, as sulphate, it will be more difficult to detect. If the solid strychnine can be obtained, it will respond very delicately to the so-called "color test." This consists in the dissolving of a small fragment in a drop of pure sulphuric acid on a white surface. If the strychnine be pure, there will be no change. If to this a fragment of potassium bichromate, manganese dioxide, lead dioxide, potassium ferrocyanide, or potassium permanganate be added and stirred with a glass rod, a brilliant play of colors is immediately produced, at first a rich blue, then violet and purple, fading into a pink, then red, and lastly a dirty green. The importance of this test depends not upon the production of one color, but upon the variation of the color and the order in which they are produced. This test is an extremely delicate one, and it is claimed that if it be properly and delicately performed so small a quantity as $\frac{1}{1000000}$ grain may be detected. If to a solution of strychnine potassium bichromate is added, a bright-yellow precipitate is formed, soon becoming crystalline. If through a solution of strychnine a slow stream of chlorine

gas is passed, each bubble of the gas will be invested with a white amorphous film which is soluble in ammonia. Before applying this test for strychnine the solution must be freed from organic matter.

Illustrative Case of Strychnine Poisoning.—Marston (*Lancet*, London, 1886, ii. 442) reports a fatal case of poisoning by strychnine. At 6.35 P. M., on June 14, a physician was called to see a man who had been suddenly taken ill. The patient was found lying on the floor, complaining of great pain over the epigastrium, a feeling of suffocation, and of being very thirsty; he was very restless and his face wore a somewhat anxious expression. He stated that he had drunk some porter from a jug which had been given to him. Sulphate of zinc was given without effect. After the lapse of ten minutes convulsions of a tetanic nature set in. The stomach-pump was introduced and the stomach thoroughly washed out with water, the washings being nearly colorless. He had two more violent convulsive spasms, with only a slight intermission between. There was great lividity of face; lips were retracted, showing the teeth firmly closed. He was quite conscious during the intervals between the attacks. During the second spasm, which was of increased severity, he died at 6.55 P. M., about fifty-five minutes after drinking the porter.

Postmortem Examination (*twenty-one hours after death*).—The whole of the body was extremely rigid, the upper extremities slightly flexed and the hands clenched; feet markedly arched; no opisthotonos; mouth tightly closed; face wore a somewhat agonized expression. Membranes of the brain and the brain-substance were congested; medulla and upper part of the spinal cord were slightly congested, but otherwise healthy. Stomach showed a few patches of congestion, and contained about five ounces of thick, grumous fluid, consisting of partially digested particles of food, and smelling of alcohol. Intestines normal and contained fluid similar to that found in the stomach. Lungs intensely congested and engorged with blood. Heart of natural size; muscular substance soft and flabby; cavities

nearly empty, the little blood they contained being fluid and very dark in color. Blood was fluid throughout the whole of the body. Bladder empty and strongly contracted. Remaining viscera normal. Chemical examination of the stomach contents resulted in the isolation of one-tenth of a grain of commercial strychnine. The washings from the stomach yielded a little more than one-tenth of a grain. In the jug from which the porter had been drunk six grains of strychnine were found.

BRUCINE.

Brucine is, as has been said, an alkaloid associated with strychnine in all parts of the tree *Strychnos Nux Vomica*, but especially in the bark. It is not so powerful as strychnine, but the symptoms produced are very similar. Its relative strength is variously described by different authors as from $\frac{1}{6}$ to $\frac{1}{40}$ of that of strychnine. It is soluble in alcohol, chloroform, and water, considerably more so than is strychnine, and has a very similar bitter taste. Its symptoms and postmortem appearances are like strychnine, and answer the same descriptions, although it is said that death from pure brucine may be produced without convulsions.

Tests.—It does not respond to the color-test for strychnine. When dissolved in concentrated sulphuric acid, it gives a faint rose-colored solution. When dissolved in nitric acid, a blood-red color is produced changing to a yellow on heating. If a drop of solution of stannous chloride be added, a beautiful purple color is produced. If to the sulphuric acid solution a small crystal of potassium nitrate is added, the rose color changes to a deep orange-red.

Illustrative Case of Brucine Poisoning.—Reichert (*Medical News*, Philadelphia, 1893, lxii. 369) concludes, as a result of extended experiments with strychnine and brucine on frogs and dogs, that the physiologic actions of the two alkaloids "are essentially identical, the difference being practically solely in degree, and not in kind." Brucine is less rapidly absorbed than strychnine, and consequently is less prompt in its actions. It is forty to fifty times less powerful

as a convulsant, and accordingly less fatal. In excessive doses it is more poisonous to the sensory nerves than is strychnine. Brucine is, ultimately, a stronger depressant to the heart, and after enormous doses more toxic to the muscles. Absorption does take place through the stomach, but with much less rapidity than strychnine. These experiments were made with brucine which was rigidly tested and found to be chemically pure.

Mays (*Therapeutic Gazette*, Philadelphia, 1885, N. S., i. 374) points out, as a result of experiments on frogs, "that in its general action brucine provokes a short period of at least motor paralysis, which is succeeded by convulsions; that the loss of motion first affects the posterior extremities; that the convulsions are spinal; that there is no marked impairment of general sensibility, but, on the contrary, preceding and during the convulsive stage there is confirmed hyperæsthesia, which is succeeded by complete motor and sensory paralysis; and, finally, that respiration ceases before the heart is arrested." The brucine in these experiments was injected subcutaneously into the backs of the frogs. Experiments performed upon reflex frogs proved without a doubt that reflex action was disturbed by sensory paralysis, when the brucine was applied locally; that it not only produced sensory paralysis in the leg to which it was applied, but by gradual absorption through the skin it also affected the sensibility of the opposite leg, and, finally that of the whole body; and that paralysis of motion follows that of sensation. Mays has also shown that pure brucine is a powerful local anæsthetic in 5 or 10 per cent. solutions on mucous membranes, and in a 20 per cent. solution on the skin.

CEREBROSPINAL NEUROTICS.

DELIRIANTS.

BELLADONNA AND ATROPINE.

Belladonna is derived from *Atropa Belladonna* or Deadly Nightshade. It is an herbaceous plant, native to Europe, but found in the United States. It occurs in moist, swampy

places, flowering in June and July, and ripening its fruit in September. This grows vigorously under cultivation and retains all of its activity. All portions of the plant are active, the belladonna being recovered very largely from the leaves, roots, and berries, the strongest extract coming from the roots. The activity of belladonna depends upon the presence of the alkaloid atropine, this alkaloid being also found in *Datura Stramonium*. Hyoscyamine, another alkaloid, is also found in small quantities in the same plants.

Symptoms.—The action of belladonna upon the animal economy is similar to and depends upon the action of atropine, the most characteristic symptoms being dryness of the mouth and throat, burning in the throat and stomach, thirst, difficult swallowing, nausea and retching, diminished vision, dizziness, intoxication or delirium, and coma. Belladonna has been used as a medicine since the earliest times, both externally and internally, either in the form of leaves, decoction, extract, or in solid form. Of late, on account of the greater accuracy and smaller size of the dose, as well as its quicker action and greater cleanliness, atropine is much more widely used than is belladonna. The tests for belladonna are similar to those for atropine, as are the symptoms and postmortem appearances. The symptoms of belladonna-poisoning usually appear within two hours after the taking of the poison. Several deaths have occurred from the eating, especially by children, of the seeds and leaves. Taylor reports the case of a boy aged fourteen, who ate soon after breakfast 30 belladonna berries. The symptoms came on in about three hours, and were of characteristic type, unconsciousness and more or less delirium at times. He made a recovery and left the hospital on the sixth day. The symptoms are in some cases said to resemble those of delirium tremens.

Illustrative Case of Belladonna Poisoning.—Taylor (*British Medical Journal*, London, 1869, ii. 555) and Molyneux (*Lancet*, 1869, ii. 327) report a fatal case of poisoning by belladonna. Male, aged sixteen, swallowed by mistake about a drachm of the extract of belladonna, dissolved in a little warm water, at about 11 P. M., immediately after having had

his supper. In about ten minutes he began to be convulsed; his eyelids were closed and remained so; his jaws were firmly shut, a little dark-colored, frothy matter oozing from his mouth occasionally. He groaned often, and it soon required the assistance of several people to keep him in bed, his convulsions became so violent. He continued in this state until 2.30 A. M. when he died, having been quite insensible from the time he had the first convulsion.

Postmortem Examination (*eighteen hours after death*).—The surface of the head, neck, chest, and arms was of a black-purple color, the lower extremities being normal in appearance. Pupils were greatly dilated. Rigor mortis well marked. Lungs were gorged with blood and almost black in color; there was a little black fluid in the cavities of both pleuræ. Heart normal; both ventricles and the left auricle were perfectly empty, and had the appearance of having been well washed out; the right auricle contained about 6 drachms of semicoagulated blood of a dark color. Abdomen was much distended. Stomach presented externally slight discoloration, which corresponded to deep red-colored patches internally; its coats were much softened, and easily torn, especially where discolored. The other viscera were quite healthy. Upon cutting through the scalp blood of a black color escaped freely. The periosteum was much congested, but the brain and its membranes were normal, the cavity of the cranium containing very little blood.

ATROPINE ($C_{17}H_{23}NO_3$).

Atropine, the active principle of belladonna, occurs in colorless or white acicular crystals, permanent in the air, odorless, having a bitter, acrid taste and an alkaline reaction, soluble in 600 parts of water, very soluble in alcohol and chloroform, and moderately so in ether. On account of its solubility atropine sulphate is the form commonly used in medicine. This occurs as a white indistinctly crystalline powder, permanent in the air, odorless, with a very bitter, nauseating taste, and a neutral reaction, soluble in 0.4 part

of water and in 6.5 parts of alcohol. The effects of this salt upon the system are the same as those of pure atropine. Atropine is inflammable, when burned giving off an odor like that of benzoic acid. It is used largely in medicine on account of its action both locally and constitutionally. Its effects are those of belladonna, the action of which is due to it. Atropine acts as a stimulant to the spinal cord and other nerve-centres, and results in an increase of the heart's action. This increase it is said is chiefly due to its paralyzing action upon the peripheral vagi. There is at first a contraction of the bloodvessels, followed by dilatation, and a corresponding fall in arterial pressure. In small doses it acts as a stimulant to all non-striated fibres. In larger doses it paralyzes them. Atropine acts upon the glandular system, more especially upon the salivary and perspiratory glands, resulting in a diminution of their functional activity. Atropine is used locally as an application to the eye, where it results in dilatation of the pupil, and externally in the form of an ointment or plaster. The poisonous effects of atropine have been produced by its absorption from external use.

Symptoms.—The symptoms produced by atropine are the same as those by belladonna, but atropine acts much more rapidly, the symptoms beginning in from one to two hours, sometimes much earlier. There are a sense of dryness and heat in the mouth and throat, nausea and sometimes vomiting, loss of vision, dizziness, drowsiness, and thirst. The pupils are widely dilated and vision may be double or indistinct. The heart's action is increased, the pulse being abnormally full and strong, the face is flushed, the eyes bright and prominent, and the conjunctivæ may be congested. Loss of speech sometimes occurs, and may be associated with frequent movements of the lips and tongue as if attempting to speak. The genitourinary system is irritated, with tenesmus, hæmaturia, and suppression of urine. More or less numbness of the extremities is common; profound coma, either with or without convulsions, usually precedes death. There is very frequently a bright scarlet eruption scattered over the body which closely simulates that of scarlet fever.

Dose.—$\frac{1}{100}$ grain is the ordinary medicinal dose, and will, in the majority of instances, be sufficient to cause a certain amount of dryness of the mouth and throat. Taylor quotes Bowles as saying that $\frac{1}{30}$ grain of atropine in two doses within one-half hour, when dropped in the eye, produced in two adults loss of vision, giddiness, dryness of the throat, loss of power of swallowing, and widely dilated pupils. $\frac{1}{8}$ grain hypodermically injected has caused symptoms of acute poisoning; $\frac{1}{4}$ to $\frac{3}{4}$ grain is probably an ordinarily fatal dose in an adult; $\frac{1}{30}$ grain of atropine is said to have caused death when injected subcutaneously; $\frac{1}{12}$ grain taken by the mouth is said by Herold to have proved fatal. Much larger doses, however, up to considerably more than a grain have been taken without producing death. According to Harley, atropine may be detected in the urine within twenty minutes after its subcutaneous injection. Death has taken place within two hours, and Herold speaks of one case in which it is said to have occurred within five minutes after hypodermic injection. As a rule, however, life persists for from sixteen to twenty-four hours.

Treatment.—The stomach should be thoroughly emptied by emesis and washing, active cathartics should be given, and in order to avoid reabsorption of the poison from the urine the bladder should be catheterized frequently. Tannic acid, iodine, and morphine are antidotal to a certain extent; diuretics and stimulants should be given as the necessity arises.

Postmortem Appearances.—The postmortem appearances of poisoning by atropine or belladonna are not very characteristic. There may be found the distinct scarlet eruption on the body, or there may be patches of localized redness on the skin and in the mucous membranes, œsophagus, or stomach. The blood is usually fluid and dark colored, the pupils are dilated. If the seeds have been taken, portions of them may be found in the alimentary canal, which will be stained more or less purplish.

Tests.—When atropine may be obtained in solution reasonably pure, the physiologic test, which consists in its introduction into the eye of man or animals, where it produces

marked dilatation of the pupil, is one of the most delicate as it is one of the most satisfactory. This test is a very delicate one, it being said that $\frac{1}{100000}$ grain may be so detected. Other substances, however, as hyoscyamine, hyoscine, digitalis, cocaine, and coniine, also have this effect, and according to Selmi, certain of the ptomaïns have the same result. If atropine is heated with a few drops of sulphuric acid and a crystal of potassium bichromate is added, a green color is produced, giving off the odor of orange-blossoms. To a solution of atropine a solution of iodine in potassium iodide gives a reddish-brown precipitate, insoluble in potash or acetic acid. If a solution of hydrobromic acid saturated with free bromine is added to a solution of atropine, a yellow precipitate is formed which becomes crystalline. This precipitate is insoluble in the mineral acids or the caustic alkalies. Most of these tests are extremely delicate, but hyoscyamine and hyoscine produce almost identical results. The crystals, however, which are produced in this latter test differ from those of either of the other alkaloids.

Illustrative Case of Atropine Poisoning.—Greenway (*British Medical Journal*, London, 1878, ii. 516) reports a case of poisoning by atropine. Male, aged forty-five years, swallowed a teaspoonful of liquor atropiæ sulphatis on August 6, 1875, at 1 P. M. At 1.39 P. M. pulse was 140, small and regular; temperature 98° F. He staggered as he walked, and complained of giddiness. Pupils not affected. At 2.45 pulse 148, full; skin was dry. Face was very much flushed. He had violent delirium, requiring three men to hold him. Pupils had gradually enlarged till they were nearly fully dilated, Tongue was dry and brown. At 3.15 P. M. pulse was 156, smaller; temperature 99° F. He was quieter, and had a tendency to sleep. He was quite unconscious. At 4 P. M. pulse 144. Respiration seemed labored and quick, accompanied by flapping of the cheeks when he was permitted to sleep. At 9.15 P. M. pulse 140, small and regular; temperature 102°; respiration 50 and laboring. At 10.35 P. M. pulse 140, full and regular; temperature 102.4°; respiration 60. At 11.45 P. M. a catheter was passed, but the bladder

was empty. He had considerable tympanites, and tenderness over the abdomen. August 7, 1.30 A. M., pulse 132, full and regular; temperature 103°; respiration 56. He passed a fair amount of urine, and complained of great thirst. At 6.30 pulse 115; temperature 100.4°; respiration 30. Bowels had acted very freely three times. At 11.45 A. M. pulse was 140, full and regular; temperature 102.2°; respiration 36. He complained of soreness at the pit of the stomach. He had perspired for the first time. Tongue and mouth less dry. Right pupil contracted slightly to light, left did not. At 9 P. M. pulse was 144, full; temperature 102.4°; respiration 52. Skin was moist. Passed urine of an amber color; specific gravity 1015; no albumin. At 10.40 P. M. pulse was 156, small; temperature 100.6°. Pupils still much dilated. Commenced to cough and expectorate. Was very thirsty. Sputum was rust-colored and scanty. August 9, 10 A. M., pulse 160, regular; temperature 100.2°; respiration 60. He complained again of pain in the right side of the chest. On examination of the chest, dulness as far as the spine of the right scapula was found, and tubular breathing and bronchophony, but no crepitation. Over the left lung posteriorly there was rough breathing. At 11 P. M. a sudden change for the worse set in, and the symptoms increased until death, which occurred at 3.40 A. M.

Postmortem Examination (*sixty-five hours after death*).—Body was well nourished. Abdomen was swollen, tympanitic, and had a green color. Right side of the chest was duller than the left. There was little hypostatic congestion. Pupils were slightly dilated. Rigor mortis not present. Pericardium contained no fluid. Heart was enlarged and very soft; the right half was much distended with dark coagulated blood; the coagula extended into the vena cavæ. Left side was empty and the muscular walls were soft. Mitral valves admitted three fingers. Pulmonary valves normal. The aorta was slightly incompetent and atheromatous. The middle lobe of the right lung was healthy and crepitant throughout; the lower lobe was hepatized and noncrepitant. There was slight exudation of blood-stained material on sec-

tion. There was no pleuritic effusion or adhesion at the base. Liver was of natural size, extremely soft, somewhat pale in color, and fatty on section. Spleen was about five inches long, very soft and friable. Kidneys were very soft, breaking down on removal. The cortex was congested and the capsules adherent. Bladder contained a small amount of urine. The œsophagus had a patch of congestion at the upper extremity, and at the cardiac end some congestion extending into the cardiac end of the stomach, which was also congested as far as its middle. Duodenum was congested at various points. At the lower end of the ileum there was a patch of redness the size of the palm of the hand. No breach of surface existed. The pia mater was excessively congested. The brain on section appeared to have more bloody points than usual; the lateral ventricles contained some bloody serum. The substance of the brain was very soft.

STRAMONIUM.

Stramonium is obtained from all parts of *Datura Stramonium*, Jamestown Weed, Thorn Apple, which is an annual plant of vigorous growth, occurring widely distributed in both of the Americas, Europe, and Asia. In the United States it is found very commonly along roadsides and the edges of cultivated fields. When it is at all bruised, its rank odor is very perceptible. All portions of the plant contain stramonium, most of which is obtained from the leaves and seeds. Its activity depends upon the alkaloid *Daturine*, which is of the same chemical form as atropine and produces much the same results. In Asia preparations of this plant are widely used as intoxicants, and in India it is said that one of the species of *Datura* was formerly used by the Thugs for the purpose of stupefying their victims. Stramonium has been used in medicine in certain forms of mental and nervous diseases; also in the treatment of various forms of neuralgia and rheumatic pain, and in the treatment of spasmodic asthma. It has been used externally in various forms of painful ulcers, hemorrhoids, etc.

Symptoms.—The symptoms produced by the taking of poisonous doses are almost, if not quite exactly, similar to those which follow the taking of belladonna or atropine, even to the extent of the eruptions.

Treatment.—The treatment is the same as that for belladonna-poisoning.

Postmortem Appearances.—The postmortem appearances are like those from belladonna or atropine, congestion of the brain with œdema in the membranes and ventricles. If the plant itself or its seeds have been used, portions of them may be found in the alimentary canal.

Tests.—The tests are similar to those for atropine. If the seeds or leaves have been taken, a microscopic examination will distinguish between them and those of belladonna. The distinguishing characteristics between daturine or hyoscyamine and atropine are very slight, according to the United States Dispensatory, the most definite being a variation in their fusing-points together with similar variations in the fusing-points of their gold chlorides.

Illustrative Case of Stramonium Poisoning.—Newton (*Medical Record*, New York, 1880, xviii. 289) reports a case of stramonium poisoning. A strong, healthy man, aged fifty years, was advised by a friend to take a decoction of burdock leaves for some fancied illness. By mistake, stramonium leaves were gathered instead of burdock leaves, and a strong decoction was made, of which the patient took about 24 fluid-ounces at 10 P. M. His bed-fellow was awakened about 11 P. M. by the restlessness of the patient, and found him unable to speak. When seen at 12 midnight he was tossing about the bed, but there were no convulsions. It was impossible for him to utter any words. The face, arms, and chest were covered with a red rash, like that of scarlatina. Tongue was dry and swollen. Pulse 170, and strong; respiration 37, and principally abdominal; temperature 104° F. The eyes were open and staring; pupils not fully dilated, and the retinæ insensitive to light. Breathing was stertorous. Vomiting could not be induced. Morphine was given in large doses hypodermically, with the result of reducing the res-

piration to 28 and the pulse to 120. It was noticed that after each injection the pulse was reduced in the number of beats and made stronger. At 12.30 P. M., the next day, the lips were blue; face ashy pale; breathing stertorous. Paralysis of the limbs was evident. Pulse 130, feeble; respiration 32. Œdema of the lungs had commenced. Body temperature, to the hand, was still high. He died at 3 P. M., seventeen hours after taking the poison.

Postmortem Examination.—All the organs of the thorax and abdomen were healthy with the exception of the lungs, which were the seat of œdema. Right heart was full of dark fluid blood. Head not opened.

HYOSCYAMUS.

Hyoscyamus is obtained from *Hyoscyamus Niger*, or Henbane, which is a biennial plant, native of Europe but growing in America. It is commonly found in the Northern and Eastern States, growing about waste places and deserted houses. All parts of the plant are active, but the drug is largely obtained from the leaves. Their activity depends upon the presence of the alkaloid hyoscyamine.

The symptoms, dose, postmortem appearances, and tests of hyoscyamus very closely resemble those of stramonium and belladonna, and this is at least partially due to the facts, first, that atropine, hyoscyamine, and hyoscine all possess the same chemical formula, they being distinguished largely on account of the variation in their fusing-points and the variation in the fusing-points of their gold chlorides. Besides this, atropine is found not only in belladonna, but also in *Datura Stramonium*, and hyoscyamine in all three, belladonna, *Datura Stramonium*, and *Hyoscyamus Niger*.

Illustrative Case of Hyoscyamus Poisoning.—White (*Lancet*, London, 1873, ii. 8) reports a case of poisoning by hyoscyamus. Woman, aged thirty-four years, swallowed by mistake 11 drachms of the tincture of hyoscyamus at 5 A. M. Ten minutes after taking the draught she had a hot, burning, prickly sensation in the hands, feet, and legs; she became

giddy and delirious, and had great dryness in her throat. Some time after, on attempting to get out of bed, she found that her legs were powerless. The whole of the body was covered with a purplish rash, more especially marked about the neck and face. Face was greatly swollen. When seen at 9 A. M. she was almost insensible and unable to speak. Tongue was swollen, brown, and very dry, and could only with difficulty be protruded from the mouth. Face was much swollen, and of a scarlet color, which was more marked on the left cheek, on which it persistently remained for four days, the rash gradually disappearing from the other parts of the body on the second day. Pupils greatly dilated. Skin hot and dry to the touch. Tincture of galls mixed with milk, and later, castor oil were administered. There was no vomiting; the bowels acted freely in three hours, and the feces were copious and of a very deep golden-yellow color, with a strong odor of the drug. Urine was freely passed. At 1 P. M. she seemed much relieved, was more conscious, was able to speak, but very indistinctly. In answer to questions she would say "yes" for "no," and *vice versa*. Her vision was so affected that she could not, when three fingers were held up, tell how many there were. All power of the lower extremities was lost and their sensibility diminished. At 4 P. M. she was delirious; face more swollen than before; temperature 104°; pulse 126; and vomiting had set in. Mustard poultices were applied to the epigastrium and citrate of potassium administered internally. Vomiting had ceased at 6 P. M. When seen at 11 P. M. she had just had a most violent fit of shivering. She was much exhausted, body cold all over; temperature 97°; pulse 56; and as she had had no sleep for eighteen hours, one drachm of opium solution in three ounces of brandy and as much water, was given. Warmth was considerably restored and she had five hours of undisturbed sleep. 9 A. M. next day temperature 103°; pulse 120, small. She could now read time correctly by a watch and articulate much more distinctly. She said she could see all sorts of horrid things, particularly when the eyes were closed. At 4 P. M. the iris had again retracted so that she

could not read time by the watch. She had several delusions, one of which was that she had no top to her head, and she could not be persuaded to feel with her hands whether such was the case or not. At 11 P. M. she was much better; temperature 100° F.; pulse 104, and increased in volume; pupils more contracted. From this time she improved steadily, but it was six days (from that of taking the poison) before she regained even a partial use of her legs, and could not then stand without being supported on both sides. She complained of having quite lost her memory; she could not connect her ideas; and talked occasionally in a rambling manner. During the succeeding three weeks she took sulphate of quinine (1 grain) and solution of strychnine (3 minims) three times a day. At the time of reporting the case she had regained nearly her original strength, ate and slept well, but complained of occasional weakness in her legs. What she most complained of was her inability to remember, even for a minute, a single sentence or word that she might read.

COCA AND COCAINE.

Erythroxylon, or Coca, is obtained from the leaves of the shrub *Erythroxylon-coca* which grows wild in various parts of South America, but is largely cultivated for the sake of its leaves. These leaves have been in use by natives of Peru since the Conquest, where their stimulating action has been well recognized and the stories of continuous exertion which have been made possible by its use are almost, if not quite, incredible. The active principle of the plant is cocaine, which occurs in colorless transparent prisms, inodorless, of a bitter taste, soluble in 704 parts of water, more soluble in alcohol, and freely so in ether. The solution has an alkaline reaction and a bitter taste, and leaves a peculiar feeling of numbness in the tongue and mouth. With the acids it forms salts which are more soluble than the alkaloid itself and which have the same action. For this reason they are used in medicine more largely than is the pure alkaloid.

Cocaine is used in medicine on account of its two physio-

logic actions, as a nerve stimulant in the form of coca wine and under various other names as a common ingredient in stimulating drinks and proprietary tonics; and is also commonly used as a local anæsthetic. The cocaine-habit is not uncommonly acquired from its use in one of these forms. The alkaloid is an ingredient in many forms of proprietary remedies for asthma, catarrh, and coryza. As a local anæsthetic it is probably the best and most reliable in use at present. Homicidal and suicidal poisonings by cocaine are rare. On account of its common distribution in the form of proprietary remedies accidental poisonings are common.

Symptoms.—Nervous excitement with a sense of oppression and fulness in the head with occasional nausea and vomiting are among the first symptoms. Headache, giddiness, loss of vision, perspiration, lividity, with rapid, irregular, and feeble pulse, superficial and gasping respiration, convulsions, paralysis, and in some cases delusions follow in sequence. In the chronic forms of cocaine-poisoning, which cases are limited largely to those who have the so-called cocaine-habit, the symptoms are those of insomnia, loss of appetite, interference with digestion, emaciation, and various forms of mental derangement. These effects come on more rapidly than in opium-poisoning, the worst results of which they closely simulate.

Dose.—$\frac{1}{6}$ grain hypodermically may cause more or less serious toxic symptoms; $\frac{1}{2}$ grain has caused death. It is not uncommon for those who have acquired the cocaine-habit to take from 3 to 5 grains per day in divided doses. Herold reports one case in which $\frac{1}{20}$ grain caused serious symptoms in a girl of twelve, and says that recovery has followed the ingestion of 22 grains by the mouth, and 10 grains administered subcutaneously. Acute and serious symptoms of cocaine-poisoning have frequently followed its application to the mucous membranes.

Postmortem Appearances.—The postmortem appearances found after death from cocaine are not characteristic. The blood as a rule is fluid and congestions of the brain and other organs are commonly found.

Tests.—From either an aqueous solution of cocaine or any of its salts, gold chloride, platinum chloride, and picric acid precipitate typical crystals. If to a watery solution of cocaine, iodine in a solution of potassium iodide be added, a rose-colored precipitate follows from dilute solutions, and a brown precipitate from concentrated solutions. If 2 or 3 drops of potassium permanganate are added to a solution of cocaine, violet crystals are precipitated.

Illustrative Case of Acute Cocaine Poisoning.—Simes (*Medical News*, Philadelphia, 1888, liii. 70) reports a case of poisoning by a urethral injection of cocaine. Male, aged twenty-nine, suffering from stricture, was placed on the operating-table and 1 drachm of a 20 per cent. solution of muriate of cocaine was introduced into the urethra by means of a long-nozzled syringe, which passed about four inches into the canal. The syringe had scarcely been taken out of the urethra when the patient made a foolish remark, the muscles of his face began to twitch, eyes staring and the pupils dilated, frothing at the mouth, face much congested, respiration interfered with, and ending in a violent epileptiform convulsion, lasting for some seconds. These convulsions were continued with increasing violence several times a minute, the whole muscular system taking part in the spasms, requiring considerable force to keep him from falling off the operating-table. The action of the heart was not much interfered with, and appeared to be only secondarily affected. It was the respiratory function that seemed first to fail, and then the heart's action became irregular and slow. The breathing was gradually more and more interfered with, the face—in fact, the entire surface of the body—became deeply cyanosed, pulse slow, and at the end of twenty minutes from the time of the first convulsion the pulse had ceased to beat and the man was dead.

Postmortem Examination.—Thorax: lungs normal, but much congested; heart normal, right side empty, left side filled with currant-jelly clots. Abdomen: liver much congested; spleen presented on its surface several stellate cicatrices; kidneys much congested, and presented cicatrices

similar to those seen on the surface of the spleen; they were thought to be syphilitic in nature. The urethra was examined for signs of rupture, but no such lesion was found. Brain: bloodvessels very much congested; the membranes on either side of the longitudinal sinus at the vertex, covering a space of two square inches, were thickened and closely attached to the brain-substance; this was probably the result of some previous inflammatory process.

Illustrative Case of Chronic Cocaine Poisoning.—Zenner (*Cincinnati Lancet-Clinic*, 1890, xxiv. 39) reports a case of cocainism: Physician, aged thirty, exhausted from overwork, determined to try the tonic effect of cocaine upon himself. He found that after injecting hypodermically 5 to 8 drops of a 4 per cent. solution he did not feel so fatigued, could work better, and, with the continuance of its use, his appetite improved and he seemed to regain his lost tone. For two months he took one or two injections daily, and then tried to lay it aside, but found that he had a craving for the drug. On one occasion he took an unusually large dose, and experienced a new sensation; he felt exhilarated and intensely happy. He drove six miles to a neighboring city, giving himself another injection on the way, and then became very reckless. He drank excessively, which he had never done before, and had to be cared for by his friends. He now took larger and more frequent doses, 10 to 20 minims, two to six times daily. He was in a constant excitable state, seeing visions of pleasure, etc. After three months he had lost his business, squandered all his property, and was brought to the brink of ruin. He took 60 minims of a 10 per cent. solution with suicidal intent, became quite sick, went away where he could get no cocaine, and took none for one month. Shortly afterward he started practice in another town, and while using cocaine at a surgical operation, happening to feel depressed, he gave himself an injection, with the result that the cocaine habit immediately returned with renewed violence. For two months he took 10 drops of a 10 per cent. solution every three hours. For a long time he experienced chiefly the enjoyable effects of cocaine. For ten minutes after he

had taken it he would seem to be in an earthly paradise. He had all sorts of pleasurable hallucinations. He would remain in his office all night, giving himself injection after injection. But a stage of depressed feelings and anxious forebodings, with delusions of observation and persecution, soon followed. He was afraid of everything, did not dare to go out after dark, and imagined he was going to be persecuted for some crime. He ran away, but the same delusions drove him from place to place, creating a state of frenzy. He had hallucinations at the same time, saw ghosts and grinning devils, heard countless voices around him. He was finally found by his brother and taken home, where he was abed three weeks in a state of active delirium. Twice afterward he again fell into the habit, each attack ending in very acute delirium, for which he was taken to an insane asylum. The first time he was in the asylum he was kept there but a short time and discharged quite well. The second time—as he found that despite all effort on his part he kept falling back into his old habits—he requested to be detained longer. He was given a position as attendant and was still there at the time of reporting his case. He first became addicted to the use of cocaine in the autumn of 1885, and entered the asylum the second time during August, 1887, and was still there in January, 1890. The whole period of his cocaine addiction was somewhat less than two years, during which time there were four periods of variable duration in which there was entire abstinence from the drug. In the beginning the quantity taken was comparatively small, but it was always largest at the time of very active mental disturbance. During the last twenty-four or forty-eight hours that he ever took it he took 20 drops of a saturated solution every two or three hours. During this time his general condition was very much affected by the drug, he had frequent fainting spells, and his pulse was 140 to 150 and intermittent. His pulse was rapid during the whole time of his addiction to cocaine, and was from 90 to 110 for three months afterward. He also suffered greatly from sleeplessness, and toward the last would go a whole week without sleep. His

appetite was poor; he often vomited and became much emaciated. But in from two to three weeks after discontinuing the cocaine his appetite would return, and he would regain his normal condition, excepting that the pulse continued to be rapid. While under the influence of cocaine he spent a large part of his time in reading and writing.

QUESTIONS.

Describe poisoning by nux vomica and strychnine.
By brucine.
By belladonna and atropine.
By stramonium.
By hyoscyamus.
By coca and cocaine.

CHAPTER XI.

DEPRESSANTS.

TOBACCO AND NICOTINE.

TOBACCO is the dried leaves of *Nicotiana Tabacium*, which is an annual plant, probably a native of tropical America. It is now cultivated in most parts of the world. Its activity as a poison depends upon the presence of an alkaloid, nicotine. It also contains nicotianin and various oils.

Nicotine when pure occurs as a colorless fluid, with a specific gravity of 1.027, boiling at 247° C., and not solidifying at —15° C.: with no very remarkable odor, an acrid, burning taste, entirely volatilizable, and when in the form of vapor very irritating. In this form its odor is similar to that of tobacco. It is inflammable, soluble in water, alcohol, ether, and the fixed oils, strongly alkaline in reaction, and forming salts when combined with the acids. All these salts are deliquescent and have a hot, burning, acrid taste. It is an extremely active poison, and has been used for purposes of homicide in a number of instances. Accidental poisonings by this alkaloid in mild form are common among those who

have not acquired by habit the power of withstanding it. It has been employed in medicine in small doses as a nerve sedative, but is not in common use.

Symptoms.—When given in toxic doses, it acts much as does prussic acid in destroying life with great rapidity. Prominent symptoms are nausea, vomiting, giddiness, muscular trembling, and great prostration. Active purging not uncommonly occurs. The pulse is rapid and weak, respiration difficult, and convulsions not infrequently occur. The pupils are usually dilated, the face is pale, the mucous membrane cyanotic, and the extremities cold. Death occurs from paralysis of respiration. All these symptoms may be produced by absorption through the skin or inhalation, as well as by ingestion into the stomach. A wet leaf of tobacco applied to the throat of a child as treatment for spasmodic croup has caused serious symptoms. According to Reese, a decoction applied to the skin of a man for eruptive disease caused death in three hours. Snuff mixed with whiskey and swallowed has caused death within an hour.

Dose.—The fatal dose of nicotine varies much with different individuals. A small fraction of a grain has frequently caused death, while recovery has followed the taking of a considerable amount. As has been said, the application of a decoction to the skin has caused death. Nicotine acts with great rapidity, and instances are on record in which death has occurred from within two to three minutes. Five or 6 grains of powdered tobacco when taken into the stomach will usually cause symptoms of gastro-intestinal irritation.

Postmortem Appearances.—There are no typical or characteristic lesions of poisoning by nicotine. As a rule if the drug has been swallowed, there is an injection of the small bloodvessels of the stomach and intestines. Congestion of the brain, liver, and other organs usually exists. The blood is commonly very dark and fluid.

Tests.—Nicotine may be distinguished from most of the other alkaloids, excepting conine, by its oily consistence and its non-crystalline character. Its odor is characteristic when heated. If an ethereal solution of iodine be added to a

similar solution of nicotine, long red crystals are thrown down. Corrosive sublimate when added to a watery solution of nicotine produces a white amorphous precipitate.

Illustrative Cases of Acute Nicotine Poisoning.—CASE I.—Weaks (*Boston Medical and Surgical Journal*, 1852–53, xlvii. 461) relates the following case of poisoning by tobacco: Male, aged seven days, previously healthy, was given at 8 P. M., October 6, for the purpose of inducing quietness through the night, two tablespoonfuls of water impregnated with tobacco smoke. When seen at 9 P. M. the entire muscular system was relaxed; pulse not perceptible at the wrist, and heart action scarcely so in the præcordial region; eyes closed; comatose; respiration spasmodic, deep, 6 per minute; deglutition very difficult; temperature high. The use of stimulants seemed to arouse the patient for a few minutes and the action of the heart increased. At 9.30 P. M. he had gradually relapsed, respiration and heart action had ceased, and he was comatose. At 4 A. M., October 7, after having breathed naturally for about thirty minutes, he suddenly expired.

Postmortem Examination (*thirty-one hours after death*).—The surface of the body was unusually red. There was an ecchymosis about the occipital and part of the temporal regions of the head. Lungs engorged with venous blood. Heart: left auricle and ventricle filled with fluid blood, right empty. Stomach externally and posteriorly was dark-colored. It contained a quantity of mucus. No odor. Mucous membrane slightly abraded in two or three small places. Brain: membranes highly injected with blood. Intestines, liver, and other viscera normal.

CASE II.—Taylor (*Guy's Hospital Reports*, London, 1858, iv. 345) reports a case of poisoning by "nicotina." On the morning of June 19, a man, aged thirty-six, swallowed an unknown quantity of nicotine from a bottle, and almost immediately afterward was seen to fall to the floor. He was carried to an adjoining room, but before it could be reached he was dead. He did not at first appear to be wholly unconscious, but he stared wildly with his eyes; there were no

convulsions, and he died quietly. Before his death he did not appear to recognize those who were around him. He died in from three to five minutes after taking the poison. The body was seen by a physician about ten minutes after death. There was no odor of nicotine about the mouth or body. There was general relaxation of the muscles, eyes were prominent and staring, features were bloated and beginning to present a livid discoloration, and there was great fulness with lividity about the neck. No appearances of convulsions or tetanic rigidity.

Postmortem Examination (*seventy-eight hours after death*).—Externally putrefaction had taken place, especially along the course of the veins. The swelling of the neck was found to arise from an effusion of dark fluid blood. Scalp, as well as the membranes of the brain, was filled with dark fluid blood. Lungs were engorged and of a dark-purple color. The cavities of the heart were empty, with the exception of the left auricle, which contained two drachms of dark-colored blood. Stomach contained a chocolate-colored fluid; mucous membrane was of a dark crimson-red color, the result of intense congestion. There was no odor except that of putrefaction. Liver was congested and puple-black in color. The blood throughout the whole of the body was black and fluid, but in some parts was of the consistence of treacle. Nicotine was found to be present in the stomach-contents, also in the liver and lungs.

Illustrative Case of Chronic Nicotine Poisoning.—Dore (*Pacific Medical and Surgical Journal*, San Francisco, 1880–81, xxiii. 308) reports a case of chronic tobacco poisoning with sudden death. Male, about forty-nine years of age, worked at the manufacture of cigars for eighteen years. A part of his work was to try the strength of the cigars made by the various workmen, so there were but few moments during the day when a cigar was not to be found in his mouth. Frequently at night, when about to leave the factory, he would complain of great weakness, particularly in his legs, for which he would resort to a drink or two of brandy for relief. He was in the habit of smoking a cigar before rising

in the morning, and after smoking all day he would smoke several cigars during the evening after dinner. He was spare of flesh and had a very slightly yellowish appearance of skin. He was not nervous, and was social and genial with his friends. On October 11 he was busy in court all the morning and did not reach his place of business until about 12 M., when he complained of a feeling of oppression in the left side of his chest. He had never had any sickness with the exception of acute rheumatism several times, from which he fully recovered, leaving no known effects on his heart or lungs. Without taking lunch he walked or rode about half a mile to his physician, who examined his heart and lungs, but found no disease or abnormal sounds. Pulse was wiry and weak, and the patient was in a profuse perspiration though it was a cool day. Finding nothing in particular, and that the patient had a cough, a mild expectorant was prescribed and he was advised to take a carriage and go home for the day. He took the carriage and was driven about half a mile to a drug-store, when he was found dead by the driver.

Postmortem Examination (*a few hours after death*).—Lungs were considerably emphysematous, particularly on the left side. Heart was contracted and empty, normal in size, and perfectly healthy. A small white clot was found in the left side, somewhat choking the aortic orifice. All the blood in the body was very dark in color. Stomach was empty; kidneys hyperæmic; liver and spleen normal. About two ounces of serum was found at the base of the brain, but none in the ventricles. Brain was otherwise normal.

LOBELIA (INDIAN TOBACCO).

Lobelia is **obtained from** the leaves and tops of *Lobelia Inflata*, which is a common weed found scattered throughout the United States along roadsides and in old fields. The plant is usually collected in August or September, when the capsules are most numerous.

Its **activity** depends upon the alkaloid lobeline, which is a

yellowish liquid, lighter than water, with a somewhat aromatic odor and an acrid, persistent taste. It is soluble in water, more so in alcohol and ether. It has an alkaline reaction, and forms salts with sulphuric, nitric, hydrochloric, and acetic acids. With tannic acid it forms an absolutely insoluble salt. It is said to have been used as a medicine by the aboriginal tribes of North America. It is now used in medicine to a somewhat limited extent, as in the treatment of various forms of laryngeal and bronchial affections. In somewhat larger doses it acts as an emetic, cathartic, and diuretic, but in doses sufficient to bring about these results there is a certain amount of danger from its use. Chewing of a few of the leaves or capsules for a short time will cause giddiness, headache, tremor, nausea, and vomiting. It has been used as an emetic and in various forms of proprietary medicines, and when used in this way indiscriminately has resulted in accidental poisoning in a number of cases. Homicidal and suicidal poisonings by its use are rare.

Symptoms.—The action of lobeline is very similar to that of nicotine, in large doses inducing nausea, vomiting, and purging, together with dizziness, interference with vision, depression of the heart and respiration, and muscular relaxation. If the dose be a very large one, there is sudden depression of the heart and respiratory action, with collapse and coma, which may or may not be associated with convulsions, and death results from paralysis of respiration.

Dose.—A drachm of the powder of lobelia has caused death. In doses of from 10 to 20 grains the emetic effects are noticeable, and may be associated with a certain amount of constitutional symptoms. When given in large amounts, life is frequently saved by the rapid emesis which follows its taking.

Postmortem Appearances.—The postmortem appearances of poisoning either by lobelia or lobeline are similar to those produced by tobacco and nicotine.

Tests.—If the powder has been taken, portions of it may usually be recovered from the stomach, and when examined under a microscope the characteristic form of the seeds and

pieces of the leaves may be detected. When this powder is treated with nitric acid, a reddish-brown color is produced, and when treated with concentrated sulphuric acid, it is blackened. If to an infusion of lobelia ferrous sulphate or ferric chloride be added, a dark-green color will be formed. Lobelia is promptly precipitated from its solutions by tannic acid in the form of an insoluble tannate. The crystals produced from the solution of lobeline by sulphuric, nitric, and hydrochloric acids are fairly characteristic. An acrid principle has been isolated from lobelia and given the name of lobelacrin. When this occurs, it is in warty tufts of a brown color, soluble in ether and chloroform, but very slightly soluble in water; it is decomposed by boiling with dilute acids or alkalies into sugar and lobelic acid.

Illustrative Case of Lobelia Poisoning.—Barker (*British Medical Journal*, London, 1860, ii. 799) reports a case of lobelia poisoning. Male child, under two years of age, had been ill, and some medicine containing lobelia had been given daily for several days. The first dose of two teaspoonfuls almost "strangled" him; in consequence of this the woman who had charge of the child did not dare to give two teaspoonfuls, as directed, four times a day; but she gave one teaspoonful twice a day. Each dose produced faintness, and seemed as if it would strangle him. The child was found dead on the morning of November 4, and no history of the symptoms previous to death could be obtained.

Postmortem Examination (*twenty-six hours after death*).—Body in good condition, not rigid, limbs quite flexible. Lower part of the abdomen and upper part of the thighs were much discolored. Penis was much discolored and its extremity red. Peritoneal cavity contained a small quantity of serum. Liver pale; gall-bladder distended with bile. Stomach contracted and empty; mucous membrane much injected, particularly toward the pyloric end; it was also deeply corrugated longitudinally. Duodenum slightly injected. Bladder contained a small amount of urine, and its lining membrane was injected, as was also that of the urethra. Kidneys, spleen, and pancreas normal. Intestines

empty. Lungs normal. Pericardium contained about six drachms of serum. Right ventricle of heart was moderately distended with fluid blood; the left empty. Head: a patch of ecchymosis was noticed beneath the scalp, on the right side, in the posterior parietal region. Membranes of the brain were very vascular, the veins being particularly distended. The cut surfaces of the brain were thickly studded with bloody points. The ventricles contained a considerable quantity of serum. Spinal cord and its membranes were preternaturally vascular, and much serum was contained in the spinal canal.

HEMLOCK (SPOTTED HEMLOCK, CONIUM).

Hemlock is obtained from the dry fruit of *Conium Maculatum*, which is a native of Europe and has been naturalized in the United States. It grows wild along the roadside and is cultivated for medicinal purposes. It flowers in June and July; the plant gives off a somewhat fetid odor, and narcotic effects are said to follow the inhalation of air loaded with this effluvia. This plant varies in its power according to weather and climate, being most active in hot, dry seasons and warm countries. The activity of the plant depends upon the presence of the alkaloid conine. The dried leaves of hemlock have a strong, heavy, narcotic odor, which is less objectionable than that of the fresh plant. The seeds have a yellowish-gray color, and a bitter taste like that of the leaves. The dark-green color of the leaves is retained in the powder.

Hemlock contains two volatile active principles, one an oil which is found in small quantities, and the other an alkaloid, conine. Conine occurs when pure in the form of a yellowish oily liquid, with a specific gravity of 0.87, a very acrid taste, and a strong, disagreeable, penetrating odor. It is volatile, boiling at 170° C. It is freely soluble in alcohol, ether, and the oils, slightly so in water. It is alkaline and forms salts with the acids, some of which are crystalline. With tannic acid it forms an insoluble salt. It coagulates albumin. Most of its salts are decomposed by heat. Hemlock has been used

for many years in medicine and as a poison. It is said to have been formerly used by the Athenians to destroy the lives of condemned criminals. It has been recommended in a great variety of diseases, and anodyne, soporific, antispasmodic, and diuretic properties are especially claimed for it.

Symptoms.—The symptoms produced by conine and hemlock are the same. In poisonous doses there are excitement, muscular weakness, and great prostration. The pupils are dilated, there are dryness in the throat, headache, drowsiness, dimness of vision, usually followed by gradually extending pain in the muscles, occasionally delirium, coma, and convulsions, but usually the mind is clear to the last. Death occurs from paralysis of respiration.

Treatment.—Emetics and stomach washing at an early stage are strongly indicated, as well as artificial respiration and stimulation.

Dose.—Death has resulted from $\frac{1}{8}$ grain of conine and from the chewing of a very small amount of the leaves. The poisonous effects of both hemlock and its alkaloid are very rapid in their onset, and fatal results have followed within less than an hour.

Postmortem Appearances.—When the hemlock itself has been taken either in the form of powder or strong solution, there may be more or less irritation of the gastro-intestinal tract. The blood is usually dark and fluid. The powder, if it has been taken in that form, may be found in the stomach and intestines, but otherwise the conditions are not at all characteristic.

Tests.—The odor both of hemlock and its alkaloid is very penetrating, and may be detected when even in very dilute solutions. This odor is increased by mixing with sodium hydroxide. This test is, however, open to the objection that a very similar odor is sometimes produced by the same reagent on other organic matter. If the powder has been taken, seeds and portions of the leaves may be detected in the contents of the stomach and recognized under the microscope. If strong sulphuric acid be brought in contact with pure conine, a pale-red color is produced increasing in inten-

sity. When the alkaloid is present in organic mixtures, its peculiar odor may be detected by distilling the material. If a solution of alloxan is added to the solution of conine, a purple color is produced, followed by a precipitate of white, needle-shaped crystals which are soluble in potassium hydrate, producing a purple color and a characteristic odor.

Illustrative Case of Hemlock Poisoning.—Bell (*Transactions American Medical Association*, Philadelphia, 1875, xxvi. 345; *Sanitarium*, New York, 1875, iii. 117) reports a fatal case of poisoning by conium. Male, aged sixty-five years, having suffered for two years from a nervous affection of the facial muscle, which cauterization, strychnine, and other remedies failed to relieve, was advised by his physicians to use certain doses of the tincture of conium. On April 3, 1875, at 10.25 A. M., 40 drops of a preparation of conium were administered; at 10.50, 40 drops more were given; at 11.15, 40 more; and at 11.45, 60 drops more. These doses were administered under the direct supervision of physicians, and were for the purpose of ascertaining the possible effects of the drug upon his system. They caused no change in his feelings, and there were no external symptoms of the action of the drug. The patient was then instructed to take 50 minims every half hour until he felt the effects, which were described to him, and then to discontinue the drug. He bought an ounce vial of the tincture, and on his return home took a dose, and dictated to his wife a description of his symptoms under the operation of the drug. The dictation of symptoms was his invariable habit when taking medicine. The paper which his wife wrote at his dictation tells its own story and reads as follows: "4.10 P. M., took 50 minims Squibb's fluid extract of conium (hemlock). 4.40, effect very decided in dizziness, relaxation of muscles and limbs; 50 minims more then taken; difficulty of walking immediately, and want of power to control movements; forced to lie down, but no mitigation of spasm; limbs and legs weak, unable to hold up head, speech thickening some, pain and heaviness in top and back part of head; pulse 56. 5.15, took 50 minims; some nausea, some

tremor at base of clavicle and in muscles across the chest, just above the sternum; no diminution of spasms about eyes, nor of photophobia. 5.25, drowsiness, inclined to sleep. 5.40, eyes difficult to open, speech difficult, fulness of throat, prostration nearly complete, diplopia (double sight) vastly increased. 6.10, nausea, twitchings on right side, unable to articulate, eyes closed, fulness almost to suffocation in throat, pulse about 60. At eight minutes past—" He was then seized with nausea but could not vomit; was very thirsty but could not swallow; he then tried to apply electricity to himself and fell back dead.

Postmortem Examination (*sixty hours after death*).—In the brain was a good deal of venous congestion. Falx cerebri slightly thickened and opaque on its anterior portion. Arachnoid and pia mater much thickened and vascular, but turning readily from brain-substance. Cruræ cerebri slightly soft. Right crus tore in removing the brain, owing to its softness, and presented a discolored appearance. Right vertebral artery much larger than normal, and had undergone atheromatous degeneration. Left vertebral artery smaller than normal, and had also undergone atheromatous degeneration. Basilar artery larger than normal, and also atheromatous; and so too the postcerebral and middle cerebral arteries. These changes extended into the smaller divisions. A small foreign growth (about as large as a grain of coffee) was found on the pia mater, just in the fork at the commencement of the cruræ cerebri. Puncta vasculosa not more than normal. Choroid plexus very vascular and thickened, otherwise brain apparently healthy. Chest: lungs much congested, full of blood, not hypostatic congestion. They were exceedingly soft, and in places tore during removal. Valves perfect. Walls of heart healthy. Left ventricle perhaps a trifle thicker than normal in proportion to the whole. Coronary arteries quite free. Aorta: only one point of atheromatous degeneration visible, about the size of a pin's head, and about half an inch from its origin. No fluid in pericardium. Abdominal viscera sound, except an undue amount of fat.

WATER HEMLOCK (COWBANE, CICUTA VIROSA).

Water Hemlock is a perennial plant indigenous to Europe and growing in moist places. It is very poisonous and is fatal to most animals, although it is said that sheep and goats are immune to its action. It has been frequently taken in mistake for parsley, and has caused in many instances fatal results. *Cicuta Maculata*, or American Water Hemlock, is very similar to the European form and has the same effect. Fatal poisoning by eating the leaves and roots is rare.

It has been used to a very limited extent in medicine in various forms of nervous and sick headache. The alkaloid in both of these plants is very similar to, if not identical, with conine, and the symptoms, postmortem appearances, and tests are the same as those produced by hemlock or conine.

WATERDROPWORT (HEMLOCK, ŒNANTHE CROCATA).

Waterdropwort is an aquatic perennial European plant, very poisonous, and has frequently resulted in accidental death when either the roots or tops have been eaten. It has in a number of instances been mistaken for wild carrot and celery. Homicidal cases have occurred, but are rare.

Symptoms.—When externally applied, either in the form of extract or of the root in solid form, it sets up a very considerable amount of irritation. Its symptoms are said to be due to a resinoid principle called œnanthin. It produces heat and burning in the mouth, œsophagus, and stomach; nausea, vomiting, headache, dilated pupils, convulsions, and difficulty in respiration.

Dose.—A comparatively small amount of the plant when eaten will cause death. 1 grain of the alkaloid is probably sufficient to cause death.

Postmortem Appearances.—Taylor quotes five cases, of which the description of one will answer for all. The face was black and froth escaped from the mouth. The postmortem appearances "revealed congestion of the brain, with black, fluid blood, engorgement of the heart and lungs, and some congestion of the mucous membrane of the stomach.

This organ contained portions of the masticated root of the œnanthe with some of the green leaves."

Illustrative Case of Waterdropwort (Œnanthe crocata) Poisoning.—Bampton (*Lancet*, London, 1881, 823) reports a fatal case of poisoning by *Œnanthe crocata*, or hemlock waterdropwort. On March 12, about 2 P. M., three sailors landed to collect water from a spring. Having finished their work, two of them dug up a plant which they mistook for the wild celery which grows in great abundance in Greece. One, whose case ended fatally, ate a root and a half, and was able to help row back to the ship and unload the boat up to nearly an hour after having eaten the poison. He was walking across the deck when he suddenly fell as if shot, striking on the back of his head, inflicting a scalp wound. He vomited some green stuff, got green in the face, with his eyeballs turned upward. He foamed at the mouth with a thick mucus, and was apparently unconscious. He could not swallow. The hands were clenched at times, and he had spasmodic contractions of the muscles of the legs and arms. About five hours after the fatal meal he was taken to the hospital in a moribund condition. At the time of admission he was unconscious; pupils widely dilated; pulse perceptible, but slowed; respiration was impeded by a quantity of thick mucus, which filled his mouth and throat and covered his beard. The extremities were cold. Muscular system was relaxed, with occasional spasmodic twitchings. As respiration failed artificial respiration was tried, but with no avail; the patient died about ten minutes after admission.

Postmortem Examination (*forty-three hours after death*).—Rigor mortis strongly marked; slight purple staining at back of neck and shoulders. Abdomen contained a small amount of gas. Diaphragm arched. Stomach distended and of a bright pink color from injection of vessels. Transverse colon contracted and contained a small amount of soft feces; no trace of vegetable fibre could be detected. Stomach contained a quarter of a pint of grumous sour-smelling material the color of treacle. No trace of root could be found; there were several scattered inflammatory patches, and some brown

discolorations where the mucous membrane was thin at the greater curvature. Gall-bladder empty. On section of liver there escaped a large amount of dark-colored blood. Spleen and kidneys normal. Bladder contracted; contained an ounce of urine. Descending colon and rectum distended; contained no feces. Right ventricle of the heart contained a small quantity of fluid dark-colored blood; the left a less quantity, thicker and darker. Muscular wall of heart relaxed and flaccid; muscular tissue soft and bloody. There were pleural adhesions. Lungs were congested and engorged with dark-colored blood. Bronchial tubes, trachea, and mouth were full of mucus. No hemorrhages from mouth, nose, or ears. Brain: dura mata was nonadherent at surface of brain. Venous sinuses were distended; meningeal vessels injected, cerebral vessels strongly so. Pia mater bled easily when cut. There was a small effusion of lymph over surface of the brain. Cerebellum was very soft, with small clots of dark blood between convolutions posteriorly. Small quantity of fluid in ventricles.

ACONITE.

Aconite is obtained from the leaves and root of *Aconitum Napellus*, Monkshood, Wolfsbane, or Blue Rocker. Its principal alkaloid is aconitine, upon which its action depends, although other alkaloids have been isolated. This plant is indigenous to Europe, and is commonly cultivated in the United States both for its flowers and as a medicinal plant. Aconite was known as a poison among the ancients, and for something over one hundred years has been used in medicine.

In moderate doses it produces a sensation of warmth in the stomach, sometimes nausea, numbness and tingling in the extremities, muscular weakness, and diminished rate of respiration. It is used in medicine to reduce temperature, and on account of its effects in reducing the irritability of sensitive nerves. When applied locally, it has the same action in reducing pain. When dropped into the eye, it causes contraction of the pupil. Accidental poisoning by aconite is not

at all rare, and cases of homicidal and suicidal poisonings occur from time to time.

Symptoms.—The symptoms produced by aconitine and aconite are the same. Death has resulted from its absorption from an external application. Immediately after swallowing there are a tingling sensation, warmth and numbness in the lips, tongue, mouth, and extremities. Dryness of the throat comes on early and is usually followed by nausea and vomiting. There are commonly pain and tenderness in the epigastrium. Sensibility is diminished; there are ringing in the ears, deafness, with modifications or loss of sight. Great muscular weakness is one of the most characteristic symptoms, comes on rapidly and is so extreme as to interfere with locomotion; the pulse is slow and weak, respiration is slow and difficult, pupils usually dilated.

Dose.—$\frac{1}{16}$ grain of the alkaloid has caused death; 4 grains of the alcoholic extract and 2 of the officinal extract have been fatal; 20 drops of the liniment have caused death. Its action is usually very rapid when large doses have been taken. Death may occur within one-half hour; in one instance it is said to have occurred in eight minutes. In other cases life may be prolonged from twenty-four to thirty-six hours.

Treatment.—The stomach should be evacuated and the most urgent symptom, which is that of extreme prostration, should be counteracted by heat and stimulation.

Postmortem Appearances.—There are no characteristic postmortem appearances. In a general way there is usually more or less congestion and the blood in the majority of cases is dark and fluid.

Tests.—There is no satisfactory chemical test either for aconite or aconitine. If the root itself has been taken, it may be discovered in the contents of the intestines and studied microscopically. The alkaloid responds very generally to the ordinary chemical tests for any of the alkaloids, and is precipitated by picric acid, tannic acid, etc. If a fairly pure solution of the alkaloid can be obtained, a satisfactory proof of its presence will depend upon its physiologic action. The

symptoms already described are so characteristic as to make a judgment based upon them reasonably accurate.

Illustrative Case of Aconite Poisoning.—Jones (*Northwestern Lancet*, St. Paul, 1884–85, 83) reports a fatal case of poisoning by aconite. Male, aged forty, took about ʒiiss of a "mother tincture" of aconite. Intense burning and pain in the throat and stomach, with difficult respiration and a feeling of impending paralysis, came on in a short time. He became mildly delirious, rushed about the room clutching his throat and gasping for breath, threw up the window, shouted murder one moment and begged for assistance the next. He was so delirious that his friends thought he was insane. A few moments before death spasmodic vomiting and purging came on. He rushed out of the door and downstairs and fell dead as he reached the bottom step.

Postmortem Examination.—Bloodvessels of the head contained a large quantity of dark fluid blood. Scalp adherent throughout. Dura was adherent along the longitudinal fissure. On separating the dura venous blood poured out in streams. Pia was everywhere engorged with blood, the space between the large vessels being uniformly red. No change in brain externally. Inner surface of lateral ventricles abnormally dry. On section brain was pale and anæmic. On opening the chest and abdomen a strong odor of alcohol was noticed. This man was intemperate in his habits. Lungs firmly adherent throughout, deeply pigmented, and slightly tuberculous at both apices. Heart walls flabby, right more so than the left, and was also much thinner and contained antemortem clots. Both ventricles filled with dark, venous blood. Mitral and aortic valves calcareous, there were also calcareous deposits on the inner wall of the aorta. Liver enlarged and fatty. Gall-bladder distended with bile, and adherent to intestine and to right kidney. Kidneys enlarged and congested. Stomach distended; external surface pale, contained partially digested meat and about three ounces of fluid which had an alcoholic odor. Mucous membrane near the cardiac orifice and along the dependent part of the stomach was congested in patches

the size of a quarter of a dollar. The inflammatory changes did not extend to the pyloric end, but this portion was highly corrugated. Intestines normal.

CALABAR BEAN (ORDEAL BEAN, PHYSOSTIGMA).

Calabar Bean is the seed of *Physostigma Venenosum*, which is a climbing plant growing along the banks of streams and found in western Africa. It is known as the ordeal bean on account of its use by the natives of western Africa as a test for witchcraft, where the person suspected of being a witch is required to drink a specified dose of a decoction of these beans. If he is not poisoned, he is acquitted. The seed is something more than one inch in length by three-quarters of an inch broad, with a very firm, hard, shining covering of brownish-red, chocolate, or ash gray. It is of irregular kidney shape, with a longer convex and a short concave edge. Several alkaloids have been obtained from it, including physostigmine, calabarine, phytosterine, and eserine, to the latter of which it probably owes its poisonous action. Eserine occurs as colorless tabular crystals with a bitter taste, melting at 90° C., and readily soluble in ether, alcohol, and chloroform, but sparingly so in water. Calabar bean and its active principle have an extraordinary sedative effect upon the spinal cord, exactly the opposite to that which is produced by strychnine. It has been used in various forms of intestinal indigestion, in chronic bronchitis, etc.

Symptoms.—Calabar bean acts as a spinal depressant. As an immediate effect of its taking there are great muscular weakness, giddiness, and general torpor. The heart is rapid, irregular, and weak, nausea and sometimes vomiting, slow respiration, contracted pupil, and not infrequently motor paralysis occur. There is occasionally purging. When dropped into the eye, it results in a sharp contraction and has caused symptoms of poisoning when thus used. The mental faculties are ordinarily clear to the last. Taylor reports an instance which occurred in 1864, in which fifty children were poisoned at Liverpool from eating these beans. One boy,

aged six, who ate 6 beans, died in a very short time, the principal symptoms being the acute abdominal pain, constant vomiting, and contracted pupils.

Treatment.—Atropine injected hypodermically seems to be a true antidote. It should be continued until the pupil reacts to the atropine and enlarges. The stomach and intestines should be emptied and the bladder catheterized in order to avoid reabsorption.

Dose.—The medicinal dose of the bean is from 1 to 3 grains, in the alcoholic extract not more than $\frac{1}{8}$ grain. It has been advised as a portion of the treatment of tetanus in doses of from $\frac{1}{4}$ to 1 grain, but such a dose is probably associated with considerable danger. In a number of instances death has occurred from the taking of several beans.

Postmortem Appearances.—If the alkaloid or the alcoholic extract has been taken, there will be nothing at all typical found upon postmortem examination. If the beans themselves have been eaten in any quantity, they will result in marked irritation of the gastro-intestinal tract. Congestion of the brain is rather commonly present.

Tests.—The most satisfactory test of a suspected solution is its physiologic action in contracting the pupil. If a few drops of the solution, even if it be quite dilute, are placed in the eye, a marked contraction of the pupil will follow in from ten to twenty minutes. If a watery solution of eserine be exposed to air in the presence of potash, soda, or lime, it becomes red from the absorption of oxygen. Its coloring-matter is taken up by chloroform, the color not being permanent, but gradually changing to yellow, green, or blue.

Illustrative Case of Calabar Bean Poisoning.—Cameron and Evans (*Medical Times and Gazette*, London, 1864, ii. 406) report 46 cases of accidental poisoning by calabar bean, of which the following case was the only fatal one: Boy, aged six and three-quarters years, who had previously enjoyed good health, was said to have eaten six beans on an empty stomach a little after 1 P. M. At 1.50 P. M. his mother saw him come staggering up the street and fall at the door of the house. When he first fell he kicked and rolled about as if

in pain, but afterward became quiet. He purged freely, but did not vomit. When carried to the hospital he was stated to have been so powerless that he could not hold his head up, and "had a heavy beating at the chest." When admitted to the hospital about 2.10 P. M. he was greatly prostrated. Pupils normal. Emetics were administered, but without result. The stomach-pump was then used, and a small quantity of thickish fluid removed. About 2.25 he was much purged, the stool being thin, watery, and of a pale-buff color. Pulse was barely perceptible, and respiration was attended with rattles; he was very cold and his face was of a livid color. He was quite conscious and able to swallow some water which was given him. Directly after drinking he died without a struggle, some froth at the time issuing from his mouth and nose. He died about an hour and a quarter after taking the poison.

Postmortem Examination (*twenty-three hours after death*).—Rigor mortis slight. Pupils rather over a quarter of an inch in diameter. On opening the skull the blood was found to be very fluid and dark; brain normal. Dura mater normal The vessels of the pia mater seemed rather distended, but probably not more so than could be accounted for by the fluid condition of the blood and the position of the body after death. No effusion in brain. There was moderately firm adhesion of the whole of the costal surface of the left lung, the upper lobe of which contained a considerable quantity of tubercle and a small cavity. Right lung pale and emphysematous. Heart was very flaccid, and partly clotted and partly fluid blood was found in both sides, the largest quantity being in the right cavities. Kidneys, liver, and spleen normal. Gall-bladder contained an ounce of thin bile. Bladder contracted and empty. Stomach contained five ounces of a thickish pulp. Mucous membrane was of a pale-pink color, a little darker in a few places. Portions of the beans with a few bits of the rind were found. The rugæ were strongly marked in narrow linear elevations. Intestines contained seventeen ounces of a fluid without smell, and in color and consistence much resembling almond emul-

sion. Mucous membrane throughout was of a pale color. Large intestine contained no fecal matter. It was found that the average weight of twelve of the beans was 65 grains.

QUESTIONS.

Describe poisoning by tobacco and nicotine.
By lobelia.
By hemlock.
By water-hemlock.
By waterdropwort.
By aconite.
By calabar bean.

Jan. 3-07

CHAPTER XII.

ASTHENICS.

HYDROCYANIC ACID.

Hydrocyanic Acid, Prussic Acid, Hydrocyanide, HCy, occurs in nature in various fruits, especially in the kernels, to a larger extent in bitter almonds, wild cherry, peach-kernels, apricot-kernels, apple-seeds, etc. In its common form it is a limpid, colorless, volatile liquid with an odor resembling oil of bitter almonds, inflammable, boiling at 27° C. Its specific gravity is 0.6969. Its taste is at first cooling, then burning, leaving an after-taste in the throat like that of bitter almonds. It is extremely volatile, and its odor so strong as to produce immediate headache and giddiness. It is readily soluble in water and alcohol. In its concentrated form it is so poisonous that even its vapor can not be inhaled without extreme danger. Dilute hydrocyanic acid answers much the same description. In its concentrated form hydrocyanic acid is one of the most dangerous and rapidly fatal poisons of which we have knowledge. In its dilute form it is used in medicine to a certain extent, especially in the more or less chronic forms of diseases of the air-passages. It has been used in various forms of mental diseases and somewhat rarely in cases of gastric irritation.

Symptoms.—When applied externally to the skin, it acts as a local anæsthetic. The inhalation of its concentrated vapor may produce death. If the dose be sufficiently large to cause death immediately, there is first a brief period of difficult respiration, slow heart, followed by convulsions, dilated pupils, vomiting, unconsciousness, then asphyxia, collapse, paralysis, and death. Death as a result of poisoning with this acid is apparently due to a paralysis of respiration. Frequently the convulsions are associated with loud cries. The action of hydrocyanic acid, when taken in large, poisonous doses, is so rapid that an opportunity is not often given for a study of its symptoms or for any treatment. The symptoms come on immediately or at the longest within one or two minutes. When seen even within this time after the taking of a poisonous dose, the conditions are those of insensibility, dilated pupils, flaccid muscles, the skin cold and moist, with convulsive breathing at long intervals. The skin and face are usually livid and froth comes from the mouth and nose.

Dose.—The smallest dose which is reported to have caused death in an adult was one equivalent to $\frac{9}{10}$ grain of the concentrated acid. 1 grain will usually be fatal.

Treatment.—On account of the rapid action of the poison and the early termination which usually follows the taking of this drug, opportunities for treatment are rarely presented. If, however, the dose is a dilute one, or if this opportunity be given, the stomach should be emptied, and the respiration stimulated by external cold, ammonia, and other respiratory stimulants. A mixture of ferrous and ferric sulphates has antidotal properties, as it forms in the stomach the inert Prussian blue.

Postmortem Appearances.—When the body is seen within a short time after death, the characteristic odor will be apparent, especially about the mouth and air-passages. The face usually appears swollen, pupils dilated, froth issues from the mouth and nose, and there is more or less lividity. The fingers and toes are contracted, blood is liquid, and the venous circulation much engorged. Mucous membranes of the stomach are reddened and a marked passive congestion is found in the

brain, lungs, liver, kidneys, and spleen. The odor of the poison may be detected in the blood.

Tests.—Silver nitrate in a solution of hydrocyanic acid gives a white precipitate which is entirely soluble in boiling concentrated nitric acid. This precipitate is crystalline in character, almost insoluble in ammonia, and the pure white color is reddened after exposure to light. In these ways this precipitate differs from that of silver chloride. Ammonium sulphide when gently heated with hydrocyanic acid gives a white precipitate to ammonium sulphocyanide. If to this precipitate a drop of ferric chloride is added, a blood-red color is formed. The same effect is produced from the vapors of hydrochloric acid applied to ammonium sulphide and then treated by the iron salt.

Illustrative Cases of Hydrocyanic Acid Poisoning.—CASE I.—Casper (*Forensic Medicine*, vol. ii. p. 90) reports a case in which "on the third day after death the cadaveric stiffening was still present, and the body quite fresh; the umbilicus alone was green-colored. Immediately after removing the calvarium, which was remarkably thin, I, as well as all my pupils present, distinctly remarked the strong odor of bitter almonds. The vascular meninges and the sinuses were remarkably anæmic. On the other hand, the lungs were much congested, with very dark-red, almost black, blood, that was frothy from cadaveric œdema. In the right side of the heart, which was also much congested, the blood was treacly; microscopically examined, the blood-corpuscles were not found to deviate from the normal. The left side of the heart was empty; the pulmonary artery was, however, distended. The trachea and œsophagus were empty and normal. The liver healthy and anæmic, the gall-bladder full; the spleen friable and easily torn. The stomach, which was, alas! quite empty (so that any chemical analysis of its contents was quite out of the question), developed a strong smell of bitter almonds. Its mucous membrane displayed the dirty-brown color of putrefaction and also cadaveric hypostasis; and this early putrefaction of the stomach was all the more remarkable from its complete non-existence in those organs which

usually putrefy earlier. Still more striking than the early putrefaction of the stomach was that of the kidneys—organs which are so late in putrefying, and which were of a uniform dark, dirty-brown color. The omenta, mesenteries, and abdominal coverings were all unusually fat. The intestinal canal was moderately full, and displayed nothing abnormal. The urinary bladder was empty; the vena cava quite distended with blood similar to that already described."

CASE II.—Draper (*Boston City Hospital Report*, 3d series, 1882, p. 110) reports a case in which the internal examination revealed: "Scalp quite fully injected. Vessels of the meninges distended with blood, but not extremely. The lateral ventricles were dry. The puncta cruenta of the cut section were moderate in number and size. The heart was distended in its right cavities; its left ventricle was firmly contracted; its structure was normal. The blood was of a dark plum color; in the cardiac cavities were some small soft coagula of dark color, with one partly decolorized, ribbon-like, and tolerably firm clot in the right ventricle. The lungs were fully engorged in all parts; the dark maroon color of the section being a little more pronounced in the lower lobes. The bronchial mucous membrane was injected. No subpleural ecchymoses. On opening the abdomen the odor of decomposition was unequivocal, although the body had been kept near the freezing-point since death. The peritoneum was pale and normal in appearance. The spleen and both kidneys were engorged. The liver was of a pale-yellow color, weighed four pounds one ounce, and was not hyperæmic. The stomach contained two ounces of thick, brown, semifluid matter; its mucous membrane was of a uniform dull pink or 'lake' color, except at fundus, where there were numerous fine dots of submucous ecchymoses; the muscular wall was thrown into thick rugæ. Except at the upper part of the duodenum, where there was a limited patch of red discoloration of the mucous membrane, the intestines were normal. The aorta contained loose dark clots; there was general venous engorgement. There was no odor of bitter almonds in any part or organ, although special care

was taken to detect it if present. Analysis by Prof. E. S. Wood determined the presence of hydrocyanic acid in the body, by means of the usual tests."

POTASSIUM CYANIDE (KCN).

Potassium Cyanide occurs as a white, opaque, amorphous, deliquescent powder, odorless when dry; when moist giving off the characteristic odor of bitter almonds, with a strong alkaline reaction. It is used to a considerable extent in the arts, especially by photographers and electrotypers, and has frequently been the cause of accidental poisoning. It is very soluble in water; less so in alcohol.

Symptoms.—The symptoms presented by poisoning with potassium cyanide are exactly similar to those from hydrocyanic acid.

Dose.—3 to 5 grains have caused death in many instances with the same rapidity and with the same symptoms as those which follow the taking of a grain or more of prussic acid.

Test.—Upon the addition of acids to this salt it is decomposed and prussic acid given off, which may be tested for. If the solution be slightly acidulated, the tests will be those for prussic acid.

Illustrative Case of Potassium Cyanide Poisoning.—Abbott (*Transactions Massachusetts Medico-Legal Society*, Boston, 1878–88, i. 394) relates a cause of poisoning by potassium cyanide. A young man, addicted to "sprees," engaged in one of them with a companion through the day of March 24, and again in the morning of March 25, during the course of the morning of March 25 he declared his intention of committing suicide. He bought a quantity of the cyanide and was seen by his companion putting the poison in a dry state upon his tongue while he lay in bed. Shortly afterward he fell to the floor, and his companion coming to his senses called for help, but he was dead before help arrived.

Postmortem Examination.—Much lividity of dependent parts and sides of neck. Eyes very bright. Labial mucous membrane rosy red. At corners of mouth, on front of chin and

within the lips, and on upper surface of tongue were many white glistening particles of the cyanide (which had been taken into the mouth and pulverized by the teeth). Heart gorged on right side with dark fluid blood, containing only one or two loose, small, dark clots. Lungs engorged; a few subpleural punctate ecchymoses on posterior surface. Spleen and kidneys engorged. Intestines not remarkable; in their contents were found some white, slimy particles (cyanide). Liver moderately injected. Œsophagus much reddened. Tongue, pharynx, and larynx were deeply injected, of a bright vermilion color. Stomach nearly empty, emitting a faint odor of almonds; fundus much reddened. Brain normal; no hyperæmia. Chemical analysis gave conclusive reaction for hydrocyanic acid in the tongue, stomach, heart, blood, kidneys, spleen, and brain, the heart, blood, kidneys, and spleen especially; none in the intestines and liver.

OIL OF BITTER ALMONDS.

Oleum Amygdalæ Amaræ does not preëxist in the almond, but results from the action of water upon the fixed oil which they contain. It has a yellowish color, a bitter, acrid, burning taste, and characteristic odor. It is heavier than water, soluble in alcohol and ether, slightly so in water, with a neutral reaction. This liquid is largely used as a flavoring for confectionery and owes its dangerous properties to the varying amount of prussic acid which it contains. The bitter almond itself has caused poisoning in a number of instances, and deaths have occurred from eating confectionery flavored with particularly impure oil. The poisonous **symptoms, post-mortem appearances, treatment,** and **chemical tests** are the same as those of hydrocyanic acid.

Dose.—The activity of the oil depends upon the amount of hydrocyanic acid contained in it, and as this varies much under different circumstances it is impossible to give any very accurate figures. In a general way it may be said that death may result from the taking of from 10 to 30 drops, and that 20 drops will usually be fatal.

CHERRY-LAUREL WATER.

This is obtained by distillation from the leaves of *Prunus Laurocerasus*, which contain an active poisonous principle or essential oil similar to that of bitter almonds. Its activity is due to hydrocyanic acid, which is contained in it. It has in a large number of cases been the cause of accidental, suicidal, or homicidal death. The symptoms, postmortem appearances, and tests are those of hydrocyanic acid.

Illustrative Case of Cherry-laurel Water Poisoning.—Casper (*Forensic Medicine*, vol. ii. p. 88) reports a case in which "a man, aged sixty years, had one forenoon, from *tedium vitæ*, swallowed about two ounces of our officinal *Aq. Lauro-cerasi*, to judge from the empty bottle which stood before his sofa. He fell immediately into a kind of swoon, and was at once attended to and placed under observation. He vomited an apple which he had eaten shortly before, and was laid upon a sofa, where I found him about an hour after. He lay quite still in a half-recumbent posture, with his head so dependent that one required to stoop in order to look into his face. His countenance was pale, and his whole body cool, his pupils much enlarged. His pulse was slow, soft, and very irregular. The most remarkable circumstance about him was the existence of a complete paralysis of motion, so that not a single voluntary muscle could be moved. Consciousness seemed not to be lost, but this could not be ascertained with certainty, since the patient could neither speak, put out his tongue, give his hand, nor evince any emotion by any play of features whatever. From time to time the most fearful convulsions passed over the countenance of this all but lifeless body, distorting its features most horribly. It was impossible for him to swallow, and therefore only external excitants could be applied. In the afternoon, about five hours after swallowing the poison, the unfortunate man died.

"The dissection was made about *twenty-four hours after death*, and the rapid advance of putrefaction was even then (in May) remarkable, as was also the strong smell of bitter almonds given forth by the body, and which was most un-

mistakably recognized both by myself and by the others who stood around. The blood in the body was dark and remarkably fluid, and a congested state of the brain and of the right side of the heart were the most striking appearances found at the autopsy."

NITROBENZOL (ESSENCE OF MIRBANE).

Nitrobenzol is the result of the action of strong nitric acid upon benzol. **Occurs** when pure as an oily, yellowish, intensely sweet liquid, with the odor of oil of bitter almonds. It has been frequently employed as an artificial and cheap substitute for oil of bitter almonds in the flavoring of soaps, foods, and confectionery.

Symptoms.—The action is that of a somewhat insidious poison whether taken in a liquid form or inhaled. It is much slower in its action than hydrocyanic acid, but, like it, is a powerful narcotic poison; the symptoms which come on within one to three hours are very similar to those of poisoning with hydrocyanic acid. It has resulted in accidental death; but few cases of homicide or suicide have been reported from its use.

Postmortem Appearances.—The postmortem appearances are similar to those of hydrocyanic acid, with the exception that gastric irritation is not so common. According to Caspar, the odor of nitrobenzol is so much more permanent and persistent that the diagnosis of poisoning from this source may be made from this alone.

Tests.—The diagnosis may be made from the fact that although the odor and symptoms are so like those of hydrocyanic acid it fails to react to any of the tests by which that acid is detected.

Illustrative Case of Nitrobenzol Poisoning.—Letheby (*Clinical Lectures and Reports*, London Hospital, 1865, ii. 39) reports a case of poisoning by nitrobenzol. A clerk was in the habit of carrying about him a small tube containing a little nitrobenzol. About 12 M. on the day of his death he applied the tube to his tongue for the purpose of removing

the odor of the pipe which he had been smoking. Soon after he felt unwell. He went home to dinner, and, feeling much prostrated, he took a glass of rum and water. At 1.30 P. M. he again applied the tube to his tongue and swallowed two or three drops of the liquid, after which he walked back to work; but finding himself worse, he consulted a physician at 2.30 P. M. He was then flushed and excited; face purplish, lips and nails of a mauve color. Skin cold; respiration short, quick, and difficult. He said he felt as if he was about to be suffocated. Heart's action irregular, pulse 130, weak and intermittent. He complained of great oppression at the chest, and confusion in the head. He was sent home in a car. He walked upstairs and lay down upon the bed. At 3.30 P. M. he was seized with tetanic convulsions (emprosthotonos), and cold water being freely dashed over his head and chest, he revived and said he felt much better. In about twenty minutes another fit ensued, which also passed away under the same treatment; but in ten minutes a third attack followed, which did not respond to the cold water, and he passed into a state of coma. He was cupped on the back of the neck; but the blood was so thick that not more than a few drachms of it would flow, and it was very black. Various remedies were tried, but without avail, and he remained in a state of deep coma for six hours, when an enema of turpentine was administered, after which his consciousness gradually returned, and he was soon able to move his limbs. Pulse remained irregular, weak, and frequent. He complained of great thirst, and drank large quantities of strong coffee, which seemed to do him good. He remained in this condition for several hours and was sensible to the last. He died fifteen hours after taking the last dose of the poison.

Postmortem Examination (*thirty-one hours after death*).—Lips were livid, but the mauve color of the nails had diminished since death. Limbs were rigid, fingers strongly flexed, jaws firmly clenched. Cornea was hazy, pupils not much dilated. Meningeal vessels much congested, the longitudinal ones being full of very dark blood; the brain on section presented

numerous vascular points from which dark blood escaped. The vessels of the spinal cord were gorged with blood. All the cavities of the heart, the coronary vein, venæ cava, and pulmonary artery were fully distended with black coagulated blood. Lungs much congested. Abdominal viscera normal. Stomach contained a few ounces of a thick dark fluid which had the odor of coffee. Stomach showed no trace of irritation.

NITROGLYCERIN (GLONOIN, $C_3H_5(NO_3)_3$).

Preparation.—When to a mixture of equal parts of strong sulphuric and nitric acids glycerin is gradually added in small quantities and the temperature of the whole is kept below freezing, an explosive fluid is produced which has received the name of nitroglycerin. It occurs as a yellowish oily liquid of a specific gravity of 1.525, without odor, of a sweet, pungent, aromatic taste, slightly soluble in water, but freely so in ether and alcohol; when entirely pure freezing at about —15° C., but when frozen occurring in long needles which explode violently when gently broken. In the liquid state it does not burn on being touched with a flame, but explodes on concussion or when touched with a red-hot iron.

It is used to a great extent in mining under the name of "blasting oil." When mixed with an infusorial earth it is known as dynamite.

It is used to a large extent in medicine as a stimulant, having almost the same action as amyl nitrite, excepting that its action is much more prolonged and the diminution in the blood-pressure is not so great. The ordinary medicinal dose is from $\frac{1}{200}$ to $\frac{1}{50}$ grain. On account of its frequent use in medicine numerous cases of accidental poisoning have occurred and one or two of homicidal poisoning.

Symptoms.—Toxic symptoms have been produced by a very small dose; temporary loss of consciousness is said to have followed $\frac{1}{45}$ grain. The ordinary symptoms produced by it are giddiness, headache, diminished vision, drowsiness, aromatic taste in the mouth, burning in the throat, and severe

pain in the region of the heart, noises in the head, and if the dose be increased, unconsciousness and delirium with cyanosis come on. There may be a considerable amount of gastro-intestinal irritation.

Dose.—$\frac{1}{60}$ grain has produced toxic symptoms; 10 drops have been a fatal dose. Death usually occurs after taking 1 or 2 drachms within from two to six hours.

Treatment.—There is no chemical antidote. Treatment depends upon stimulation, emptying the stomach, and overcoming prostration, which follows within a few minutes after the taking of a large dose. If the stomach be not emptied within a comparatively short time, recovery rarely takes place.

Postmortem Appearances.—There is congestion of the brain both superficial and deep, and more or less œdema, and the ventricles usually contain fluid. The œsophagus, stomach, and upper small intestine show signs of irritation, and in a number of instances small spots of ecchymosis have been found underlying the mucous membrane of the stomach and small intestine. The lungs are usually congested.

Illustrative Case of Acute Nitroglycerin Poisoning.—Nyström (*Upsala Lakaref, Forh.*, 1866–67, ii. 232) reports a fatal case of poisoning by nitroglycerin. A man drank a considerable amount of the oil from a flask in mistake for beer. An hour later he was blue in the face and insensible. When admitted to the hospital he was insensible and delirious, and speedily became comatose. The hands were frequently raised to the head. Face was red and swollen. There was dyspnœa, and loud mucous râles were heard over the whole of the chest. Death took place six hours after swallowing the poison.

Postmortem Examination.—Brain and its membranes were congested, and there was some yellow serous fluid in the ventricles. Brain-substance firmer than usual. Lungs were œdematous and firmer than usual. Trachea hyperæmic. Kidneys and stomach hyperæmic. There were numerous small ecchymoses about the fundus and cardiac end of the stomach. Small intestine showed signs of irritation. A sweet odor was perceptible when the abdomen was opened.

Illustrative Case of Chronic Nitroglycerin Poisoning.—Laws (*International Clinics*, Philadelphia, 1899, 8 s., iv. 1–15) gives a summary of his observation on glonoinism. All workmen employed in nitroglycerin factories, and all others who are in any way brought into contact with nitroglycerin or its compounds, suffer from what is known as the "powder headache." The workmen's wives, and others who do the laundry work, suffer severely on washing-days. Nitroglycerin when taken into the system by absorption or inhalation acts on the vasomotor centres, causing dilatation of the left side of the heart and of the entire arterial system. There is often a distinct reddening of the skin of the face and extremities, sometimes of a pinkish hue, which occasionally increases to lividity and blueness of the finger-nails, lips, ears, and nose, with conjunctival injection. Along with this there is palpitation, even thumping of the heart; pulse slightly thickened, soft and compressible; and an intense throbbing pain in the head, worse in the occipital region, and extending down the back of the neck. At every pulsation of the heart the blood can be felt surging through the brain, and in severe cases the movement of the blood can be felt in other parts of the body. The one affected walks lightly on his toes, as touching the heels to the ground sends an additional darting pain to the head. Nausea and vomiting are often present, and sometimes diarrhœa. Weakness and prostration, and languor continuing over the next day, are always present. Some are more affected than others, but all are affected to a less or greater degree. Occasionally the headache is absent, but nausea and vomiting or diarrhœa is present. In about a week's time the new men become accustomed to the poison, and do not suffer from the headache, but nitroglycerin is rapidly eliminated and the immunity is not permanent, for after two or three days' absence from work they have another, generally lighter, attack on exposure, and many of them have a "powder headache" every Monday morning. After the headache and other acute symptoms disappear another condition is gradually developed, worse in some than in others, but present to a certain degree in all. This condition is

dependent on a dilatation of the heart, particularly the left side, and of the entire arterial system. The pulse is soft, weak, and is obliterated by moderate pressure. The first sound of the heart is accentuated, the apex-beat exaggerated. Murmurs resembling anæmic murmurs are heard, but most frequently from aortic regurgitation and occasionally from mitral insufficiency. There is engorgement of the left ventricle; the heart often acts irregularly and palpitates easily. All the symptoms are aggravated, the heart acts tumultuously, the breathing is rapid and unsatisfying on active exertion, and the man easily becomes tired and exhausted. A peculiarity is that the heart-sounds can be heard all over the chest, on the right side as well as on the left, probably due to the increased amount of blood in the pulmonary arteries. The appetite is poor, especially for breakfast. New men at the business lose weight rapidly, often from ten to thirty pounds. Bowels are sometimes constipated. Kidneys are not affected, there are no dropsical effusions, and swelling of the feet and ankles is rare. Examination of the urine shows no traces of sugar or albumin, no marked acidity, and no especial change in specific gravity. There is a certain degree of mental dulness, particularly noticeable during working-hours. This physical condition is the rule among the workmen to a greater or less degree, according to amount of exposure, previous condition of health and strength, habits of living, idiosyncrasy, etc. A drink of whiskey or brandy will cause an aggravated form of the primary affection, headache, thumping of the heart, reddening of the skin, lividity of face and lips, and oppressed breathing. Intoxication is produced easily, and is often accompanied by maniacal delirium and subsequent stupor. A single glass of beer will cause headache, palpitation, and reddening of the skin.

DIGITALIS AND DIGITALINE.

Digitalis is obtained from the leaves of *Digitalis Purpurea*, or purple foxglove, which is a biennial or perennial plant indigenous to temperate Europe and cultivated largely in this country for ornament and medicinal use.

There are a number of active principles to which the term digitaline has been applied by various chemists, and this term is used indefinitely for more than one compound. By others these active principles are recognized under the names of **digitaline, digitoxine, digitalein,** and **digitoneine.** In addition to its active principles there are two acids one of which is fixed, digitalic acid, the other volatile and *antirrhinic*. Still other chemists consider digitaline as a complex body composed of digitine, digitalitin, and digitaloin. Digitalis has been used very freely as a medicine, largely on account of its action upon the heart and kidneys. It is supposed to act upon the heart by stimulating the peripheral ends of the inhibitory nerves and also by stimulating the heart-muscle, so increasing the amount of work by the heart. Digitaline occurs in its crystalline form in brilliant acicular crystals. In this form it is insoluble in water, soluble in chloroform and dilute acids. Another form is the amorphous digitaline, a white powder with a neutral reaction, more or less soluble in water.

Symptoms.—When given in medicinal doses, the action is slow and the pulse full and bounding. When the dose is increased, it is followed by gastric depression, nausea, vomiting, and diarrhœa. In increasing dose there are some giddiness and feeling of fulness in the head, and confusion of thought. In toxic doses the pulse becomes very rapid, there are extreme prostration, delirium, stupor, convulsions, and death by syncope. Digitalis also has powerful action as a diuretic even when applied externally. The action of digitaline is very similar to that of digitalis, but not completely, as there are probably other active principles. As a rule the pupils are dilated and there may be severe abdominal pains. Salivation and suppression of urine have been noted in some cases.

Dose.—Digitalis is a cumulative poison, so that repeated doses are apt to have more serious effect than that resulting from one large one, but while from 10 to 20 grains three or four times a day is the ordinary medicinal dose of the tincture, its use in larger doses, even up to and above ½ ounce, is not very rare, and is not usually followed by serious symptoms. Fatal results, however, have followed a much smaller dose than this. $\frac{1}{16}$ grain of digitaline has caused symptoms of poisoning, and it is probable that ½ grain would cause death in the average individual.

Postmortem Appearances.—The postmortem appearances are not characteristic. They will depend to a considerable extent upon the form in which the poison is taken. If digitalis is taken in the form of seeds or powder or in a single large dose in solid or liquid form, there will probably be a considerable amount of gastrointestinal irritation. If death results from its cumulative action or from the effects of digitaline, these conditions will probably not be present. Congestion of the brain with œdema is usually present.

Tests.—If a few drops of a mixture of sulphuric acid and alcohol be added to and heated with digitaline, a light yellowish-brown color is produced. If digitaline be dissolved in strong sulphuric acid, a green color is formed. Bromine-water changes this to a reddish violet, and if this now be diluted with water, it becomes an emerald green. Strong nitric acid dissolves digitaline with effervescence and the production of red fumes. These tests are not sufficiently characteristic, and the physiologic test depending upon its action upon the heart when injected into the veins of a frog or other small animal is perhaps the most valuable. If the seeds or leaves have been taken into the stomach, they may be discovered and microscopically studied.

Illustrative Case of Digitalis Poisoning.—Köhnhorn (*Vierteljahr. f. gericht. Med.*, 1876, xxiv. 278) reports a fatal case of poisoning by digitalis. A young German conscript, who had on examination been declared healthy and fit for military duty, went to a "liberator" to get the means for avoiding the same. This man gave him a box containing one hundred

pills, with directions to take four pills twice daily. A short time before his entrance into the army, perhaps eight or ten days, he began to make use of the pills. He entered the army on December 12, 1874, and three days afterward announced himself sick, and was treated in the barracks for a few days and admitted to the hospital on the 18th. He complained of loss of appetite, nausea, constipation, headache, and dizziness. On examination the ill appearance and a strong smell from the mouth were noticeable. Tongue was heavily coated; pressure over the stomach caused so much complaint of pain that there arose a suspicion of exaggeration. No fever. Pulse 56. There were no other symptoms. In spite of appropriate treatment he did not improve. On December 21 pulse was 52. On December 26 he vomited, and the vomitus contained some greenish slimy masses. His condition remained the same till the end of the month, and he lost more or less strength. He complained of darkness of vision, noises in the ears, and great weakness. Pupils reacted well and were of equal size. On January 9 he complained of swelling in the neck and difficult deglutition. Examination showed no reason for the swelling. The physician wished to make an examination of the abdomen with the patient in an upright position, but the patient could not stand on account of faintness, which disappeared after a few minutes' rest. He had hiccough. Early in the afternoon he wanted to get up, and had hardly arisen from his bed when he sank down and died almost immediately.

Postmortem Examination (*twenty-two hours after death*).—Body well nourished, muscles pale. Blood was thinly fluid, nowhere coagulated, and of dark cherry-red color. Lungs normal; hypostatic congestion present. The lower part of the trachea contained some foamy liquid. Heart normal, right half filled with dark fluid blood, left empty. Stomach contained about 200 c.c. of a greenish-yellow turbid fluid with single white flakes. Mucous membrane of stomach showed circumscribed areas of injection; in these areas the bloodvessels were much enlarged, here and there were small ecchymoses. Mucous membrane

of the duodenum and of the rest of the small intestine showed the same hyperæmic areas as the stomach. Duodenum contained a thick, almost mushy mass, mixed with mucus and of a cloudy yellow color. The greenish color of the stomach-contents was less noticeable here. The contents of the intestines beyond the duodenum were of a more solid consistence, and the lower portion of the small intestine and the whole of the large intestine contained feces of a yellow color and good consistence. Liver normal. Gall-bladder contained some dirty brownish liquid. Spleen, kidneys, ureters, and bladder normal. Bladder contained a moderate amount of clear urine. Dura mater normal; pia mater showed some patches and opacities at the sagittal suture. Brain somewhat anæmic; sinuses contained but little blood. The stomach, part of the œsophagus, and pieces of the liver and duodenum were analyzed together and yielded digitalis. The stomach-contents gave the reaction of digitalis, and several of the small greenish particles found in the stomach were proved to be digitalis by microscopic examination. Digitalis was present in the contents of the duodenum. Analysis of the blood was negative. Chemical and microscopic examination of the pills showed them to consist of digitalis powder.

COCCULUS INDICUS (LEVANT NUT).

Cocculus Indicus is a fruit of *Anamirta Cocculus*, found in the East Indies, and depends for its activity upon the presence of a poisonous, bitter, neutral principle, picrotoxin. It is used for destroying fish and vermin, and it is also said to be employed for the production of the characteristic bitter taste in malt liquors. It is said to be used externally in the various forms of skin diseases.

Symptoms.—When taken internally, it acts as a narcotic irritant poison, giving rise to acute symptoms of gastro-intestinal irritation. Picrotoxin, the active principle, occurs as colorless crystals, somewhat soluble in water, very soluble

in alcohol, ether, and chloroform. It is not an alkaloid, but a glucoside.

Dose.—Comparatively few of the nuts are required to cause toxic symptoms. The external application has resulted in toxic and even fatal poisoning.

Treatment.—The stomach should be emptied, the convulsions treated by sedatives, such as chloral and chloroform, and the prostration which follows combated by stimulants, heat, etc.

Tests.—Cold sulphuric acid has no effect. When heated, an orange-yellow color is produced. Strong nitric and hydrochloric acids have no effect upon it. When boiled with copper sulphate and sodium hydroxide, it reacts as does grape-sugar.

Illustrative Case of Cocculus Indicus Poisoning.—Shaw (*Medical News*, Philadelphia, 1891, lix. 38) reports a case of poisoning by a concentrated tincture of cocculus indicus. Male, aged fifty-one, had been in poor health for ten years. About five years previously he bought, as he supposed, some wild cherries, and got a druggist to put them in a half-pint flask filled with brandy. Of this he took teaspoonful doses at irregular intervals, without experiencing any untoward effects. The flask was put away, and remained undisturbed and forgotten for about five years until two weeks prior to his death. At this time he took the flask containing the dry berries, which he still supposed were wild cherries, but were really fishberries, and had it filled with whiskey. Of this tincture he took small doses for upward of a week. One morning, at about ten o'clock, he took a considerable quantity from the flask, and afterward complained of feeling dizzy and sick at his stomach. He excited vomiting by tickling the fauces, and felt relieved, but in a few moments fell to the floor in a convulsion. Convulsions of a tonic and clonic character followed in quick succession, until death took place. During the convulsive stage unconsciousness was complete. He died thirty minutes after taking the large dose of the tincture.

Postmortem Examination (*nine and a half hours after death*).

—Rigor mortis marked. Body was excessively fat. Lungs healthy. Right lung was adherent throughout the chest. Heart was contracted in systole and empty; perfectly healthy. Liver fatty and enlarged. Spleen flabby and friable. Kidneys fatty and enlarged. Stomach was excessively dilated and empty, the mucous membrane congested in spots. Brain and spinal cord not examined.

TAXUS BACCATA (YEW).

Taxus Baccata is a common European evergreen tree, the fruit and leaves from which when eaten produce violent irritant narcotic poisoning. It is poisonous alike to the various animals and man, its activity depending upon the alkaloid **taxine**, and in addition to which it is supposed the leaves contain a poisonous volatile oil. It has been used in some localities to produce abortion, and on account of the bright appearance of the berries it is not rare for children to eat them. In these two ways most of the cases of poisoning have occurred.

Symptoms.—When the leaves or berries have been eaten, the symptoms presented are similar to those from any of the irritant narcotic poisons: nausea, vomiting, gastric pain, cold perspiration, dilated pupils, increasing difficulty in respiration, delirium or convulsions, coma, and death.

Treatment.—Treatment consists in emptying the stomach and intestines and treating the symptoms as they arise.

Tests.—The only satisfactory proof of poisoning by this means is recovery from the stomach and intestines of portions of the seeds and berries.

Illustrative Case of Taxus Baccata Poisoning.—Deas (*British Medical Journal*, London, 1876, ii. 392) reports a case of poisoning by leaves of yew. Female, aged forty-one, suffering with chronic melancholia and dementia, appeared to be in her usual health on February 1 and ate a good breakfast. About 11 A. M. she went out into the airing court for a short time with other patients and two nurses. Between

11 and 12 o'clock the doctor visited the ward himself and found nothing unusual. Shortly after this he was summoned to the patient, who, it was stated, had been suddenly taken ill. She had been found lying on the floor in a fainting spell. When seen she was apparently in a faint, face pale, eyes closed, pulse almost imperceptible. Stimulants were given and she revived somewhat, said she felt very faint, and in a few minutes she became worse again. She became unconscious and the facial muscles were convulsed, chiefly on the left side, the head itself being drawn to that side. Eyes were turned up, pupils contracted. The arms were drawn up and there was general restlessness. The facial convulsions were similar to those seen in epilepsy, and ended in frothing at the mouth and stertorous breathing. A short period of quiescence and semiconsciousness ensued. Heart's action continued very weak, and the extremities were cold. Convulsive seizures took place three or four times at short intervals. Consciousness never returned, the heart's action became weaker and weaker; respiration slow with long intervals. She died within an hour from the time when she was first found to be ill.

Postmortem Examination (*twenty hours after death*).—No organic disease was found to account for death. Brain and membranes congested. Sinuses and veins were filled with dark liquid blood, as were also the large veins throughout the body. Internal organs all normal, but venously congested. Stomach contained a small quantity of green-tinted watery fluid, a small quantity of leaves, and six or seven small seeds mixed with glairy mucus. There were a few patches of moderate congestion. The leaves were of two different kinds, yew and holly. The yew leaves weighed 5 grains, and were all quite fresh, and had not been long in the stomach. The seeds were holly seeds. Duodenum contained some green-tinted fluid and was somewhat congested. It contained two yew leaves. The upper portion of the small intestine was somewhat congested.

QUESTIONS.

Describe poisoning by hydrocyanic acid.
By cyanide of potassium.
By nitrobenzol.
By nitroglycerin.
By digitalis and digitaline.
By *Cocculus indicus*.
By *Taxus baccata*.

CHAPTER XIII.

PTOMAINS.

Ptomains and Ptomain-poisoning.—During putrefaction certain chemical processes take place induced by the action of bacteria. These chemical processes result in the formation of chemical compounds in wide variety and with varying action. Some of them are extremely poisonous, others entirely bland. To a large number of these compounds the term ptomain has been applied. The subject is a very large one, and the number of ptomains that have been isolated equally large, and it is impossible in the allotted space to go to any extent into the details of the subject. They are, however, of medico-legal importance in three ways: first, because ptomain-poisoning may so closely resemble poisoning by the various irritants as to make the diagnosis difficult. Secondly, because in their chemical reactions certain of the ptomains simulate very closely the reactions of other chemicals, frequently the cause of accidental, suicidal, or homicidal death; substances are formed after death, and may be recovered from the organs, which respond very closely to the recognized tests for better known poisons, and by their response make it difficult to state accurately whether or not a certain vegetable alkaloid has been absorbed during life or created after death. Thirdly, they are of importance in that homicidal poisonings may in the future, as they have in the past, result from the intentional use of these animal alkaloids.

Accidental Poisonings by Ptomains Simulating other Forms

of Acute Poisoning.—This subject has already been considered under the head of decomposition in animal foods. Space will not permit of going further into details, and it need only be said that we should recognize not only the fact that the poisoning by putrefying animal food may cause symptoms very closely similar to those produced by other irritant poisons, but also that chemical compounds formed under such conditions, and found in the body after death, may respond to the same tests as would other irritants whose presence is suspected.

Ptomains are the result of bacterial action, particularly those forms of bacteria which are constantly found in the human intestine. During life the solid viscera and the muscles are, as a rule, free from such bacteria and their products. After death and immediately before death these organisms multiply with great rapidity and extend in their growth out from the intestinal canal into the organs and muscles until the entire body may be subject to their influence. This growth may take place long before any external signs of putrefaction present themselves, and during this growth produce these chemical compounds, or ptomains, so that it is entirely possible to find within a comparatively short time after death, and before evidences of putrefaction have presented themselves, bacterial products in any and all of the solid viscera and the muscles. There have been isolated a very large number of ptomains, including among them some which produce symptoms and reactions like the more common vegetable alkaloids, among them being ptomains which apparently duplicate the actions and tests of such well-known alkaloids as atropine, conine, nicotine, strychnine, digitaline, colchicine, veratrine, and curarine.

Atropine.—A ptomain has been found in corned beef, sausage, decomposed fish and game, which, when taken into the stomach, produces symptoms very closely like those from atropine. The name ptomatropine has been sometimes given this substance. It produces great thirst, dryness in the throat, inflammation of the mouth, dilatation of the pupils, paralysis of the muscles of the eye; the action of the heart

is increased in rapidity, there is great prostration, and death results from cardiac paralysis.

Postmortem Appearances.—The postmortem appearances are those of irritation of the œsophagus, stomach, and intestines, passive congestion of the brain, lungs, and kidneys, and degeneration of the heart muscle. This substance responds to many of the chemical tests for atropine, including that with platinum chloride.

Morphine.—Vaughn reports a case in which he was requested to examine a stomach and liver for morphine. Following out Dragendorff's method, he obtained a substance which produced all of the color tests for morphine, but did not produce morphine crystals. He reported that no morphine was found, and it was subsequently proved that the cause of death was injury of the head.

Nicotine.—Nicotine-like substances have been recovered from the upper intestinal canal after putrefaction had set in which responded to many if not all of the tests for nicotine, where poisoning from nicotine was incredible.

Strychnine.—Substances simulating very closely strychnine have been detected in decomposing bodies, and also in decomposing cornmeal. In one instance they reacted to all the tests for strychnine, with the exception that the ptomain was but slightly bitter, while strychnine is extremely so. Other substances have been found also much like strychnine, but non-crystalline and more soluble. The same might be said of colchicine, veratrine, curarine, and digitaline.

There are many ptomains which have been isolated and whose poisonous activity has been thoroughly demonstrated. They have been recovered from various sources, including foods and decomposing animal matter of various sorts. Many of these when introduced into the smaller animals are followed by symptoms of violent poisoning, as a rule simulating in their action those produced by the narcotic irritants. Fatal results in some instances occurred within a very few moments, while in others life was prolonged for many hours or a few days. It is impossible in the space allotted to go into the details of chemical composition, symptomatology, etc. A few

of the most important are tyrotoxine, tryptotoxine, mydaleidine, neurine, susatoxine, methyl guanidine. Even if space would justify our going into the detail of the toxicology of ptomains, chemical knowledge at this time is not sufficiently accurate to justify us in treating at great length these matters. It is sufficient to call attention to them and to impress the importance of appreciating the possibility of error, especially in the diagnosis of narcotic irritant poison, whether that diagnosis be based upon the symptomatology, postmortem appearances, or chemical reaction.

QUESTIONS.

What are ptomains, and to what extent do they simulate poisoning by other chemical compounds?

Describe ptomain-poisoning.

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